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Feeding Characteristics of Infants Presenting or Admitted to a Paediatric Hospital

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Abstract

Background

Appropriate infant feeding practices are of fundamental importance for the survival as well as the growth and development of infants[1]. Optimal infant feeding of breast milk has been reported as reducing the incidence of disease by contributing to both the passive protection and the development of the immune system of the infant[2,3] and improves long term health outcomes[4]. As a consequence, sick and vulnerable infants have the most to gain from the benefits of breast milk, yet there is a paucity of research specifically on infant feeding in infants presenting and/or admitted to paediatric facilities[5]. The exception to this is preterm babies where the benefits of breast milk are well reported[6].

Moreover, feeding mode has not been investigated as a potential primary reason for presenting to a paediatric hospital. Studies in this area are primarily done to assess risk and benefits of the type of infant feeding in relationship to illness, such as breast feeding or formula feeding in relation to the occurrence of respiratory tract illness.

The focus of this study was to identify, explore and clarify the infant, maternal and socio-demographic factors that may influence feeding before the infant presents to hospital, the impact of feeding on the reason for presentation, and the factors that affect infant feeding in hospital.

Aims

The overall aim of this thesis was to investigate feeding history and presentation and/ or admission to a paediatric hospital of infants (aged 0-12 months of age). The primary outcome was to determine what relationships exist between the mode of feeding and the reason for presentation and/or admission to hospital. Secondly to identify other factors that co-exist with feeding factors that modify the reason for presentation or admission. Finally, the relationships between infant feeding practice and diagnosis and or admission to hospital are examined.

Background information is presented in Chapter 2. Chapter 4 presents a peer-reviewed paper of a systematic review of infant feeding experience and hospitalisation in developed countries. This review found no clear relationship between mode of feeding and reduction of infant hospitalisation for illness in developed countries.

Chapter 5 presents phase one of a chart audit identifying if infant feeding was documented in charts of infants presenting and/ or admitted to a paediatric hospital as a peer reviewed paper. This audit found that the recording of a comprehensive infant feeding history is not recorded on many occasions of infant presentation and or admission to hospital.

Chapter 6 is the second phase of the chart audit, an audit of measurement of growth at presentation and/ or admission to a paediatric hospital. This phase of the audit found that infant measurements were not recorded on many occasions. Assessment of growth as a marker of illness or nutritional deficit has been poorly assessed in this group.

In Chapter 7, the first phase of information from a prospective questionnaire-based survey of parents aimed to ascertain information about infant feeding and ill health prior to the infant's presentation at the emergency department or admission at a tertiary paediatric hospital is reported. Feeding history and sociodemographic data are reported in this paper, which has been submitted for publication. The findings presented in this paper would suggest that the choice of infant feeding, sociodemographic characteristics and disease category is associated with infant presentation and or admission to hospital. In Chapter 8, further findings from the survey of parents with additional data from admission are presented.

Finally, Chapter 9 concludes the thesis by summarising the findings, presenting the major discussion points, and describing the limitations of the research presented. The final message of the thesis is that, overall the importance of a feeding history and record of growth in hospitalised children is undervalued. This is the first study that we know of that has accurately identified infant feeding on admission to hospital.

Declaration by author

This thesis is composed of my original work, and contains no material previously published or written by another person except where due reference has been made in the text. I have clearly stated the contribution by others to jointly-authored works that I have included in my thesis.

I have clearly stated the contribution of others to my thesis as a whole, including statistical assistance, survey design, data analysis, significant technical procedures, professional editorial advice, and any other original research work used or reported in my thesis. The content of my thesis is the result of work I have carried out since the commencement of my research higher degree candidature and does not include a substantial part of work that has been submitted to qualify for the award of any other degree or diploma in any university or other tertiary institution. I have clearly stated which parts of my thesis, if any, have been submitted to qualify for another award.

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Publications during candidature

Peer-reviewed publications

Williams LA, Davies PSW, Boyd R, David M, Ware RS A systematic review of infant feeding experience and hospitalisation in developed countries. Acta Paediatrica, 2014; 103,131-138 doi: 10.1111/apa12477

Williams LA, Ware RS, Davies PSW Hospital, infants and feeding: the importance of audit. Journal of Paediatrics and Child Health. 2015 doi:10.1111/jpc.12824

Williams LA, Ware RS, Davies PSW Back to basics: An audit of measurement of infant growth at presentation to hospital. Australian Health Review 2015 doi: 10.1071/AH14165

Williams LA, Ware RS, Davies PSW. Characteristics of infants who present to a paediatric hospital: feeding history. Submitted for publication in Archives of Disease in Childhood.

Williams LA, Ware RS, Davies PSW. Getting the real picture of the infant admitted to hospital: breastfeeding and health. Submitted for publication in Acta Paediatrica.

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Peer reviewed abstracts

Williams LA, Ware RS, Davies PSW. A systematic review of infant feeding and hospitalisation in developed countries. Oral presentation at Queensland Children's Medical Research Institute Student Expo 15th August, 2013. Royal Children's Hospital Auditorium. Herston, Queensland.

Williams LA, Ware RS, Davies PSW. The importance of assessment of growth of infants at presentation or admission to a tertiary paediatric hospital: are we missing something? Oral presentation at The Nutrition Society of Australia and Nutrition Society of New Zealand 2013 Joint Annual Scientific Meeting. 4th – 6th December, 2013. Brisbane, Australia. Published in conference proceedings.

Williams LA, Ware RS, Davies PSW. A true picture? The assessment of infant feeding in hospital records. Poster presentation at The 2nd International Conference of Nutrition and Growth. January 30th-February 1st, 2014. Barcelona, Spain. Published in conference proceedings

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Contributor	Statement of contribution
Author Williams LA (Candidate)	Conception and design (60%) Reviewing literature (70%) Statistical analyses and interpretation (60%) Writing manuscript (100%)
Author Davies PSW	Conception and design (10%) Critical review of manuscript (30%)
Author Boyd R	Conception and design (5%) Critical review of manuscript (10%)
Author David M	Reviewing literature (20%) Critical review of manuscript (10%)
Author Ware RS	Conception and design (25%) Reviewing literature (10%) Statistical analyses and interpretation (40%) Critical review of manuscript (50%)

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Contributor	**Statement of contribution**
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Author Williams LA (Candidate)	Conception and design (70%) Statistical analyses and interpretation (50%) Writing manuscript (100%)
Author Ware R	Conception and design (15%) Statistical analyses and interpretation (40%) Critical review of manuscript (50%)
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Author Ware R	Conception and design (20%) Statistical analyses and interpretation (40%) Critical review of manuscript (60%)
Author Davies PSW	Conception and design (10%) Statistical analyses and interpretation (10%) Critical review of manuscript (40%)

Contributions by others to the thesis

My supervisors, Professor Peter Davies and Dr. Robert Ware were involved in the conception and design of the overall research project, critically revised the content and associated analyses and contributed to the interpretation of ideas and concepts presented in the thesis. Professor Roslyn Boyd and Dr. Michael David contributed to the systematic review.

Statement of parts of the thesis submitted to qualify for the award of another degree

None.

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Keywords

Infant, hospitalisation, breast feeding, bottle, feeding, developed country, audit, paediatric.

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List of Abbreviations used in the thesis

AIHW	Australian Institute of Health and Welfare
ATSI	Aboriginal and Torres Strait Islander
BFHI	Baby Friendly Hospital Initiative
BF	Breastfed/breastfeeding
ED	Emergency Department
ICD	International classification of disease (codes)
SEIFA	Socio-Economic Indexes for Areas
UK	United Kingdom
USA	United States of America
WHO	World Health Organization

CHAPTER 1: INTRODUCTION

1.1 Infant presentation and or admission to hospital

1.1 Background

Infants comprised approximately 30% of all presentations of children to the age of 16 years in the 2012-2013 financial year to a Brisbane tertiary paediatric hospital emergency department[7]. Infants admitted to the hospital in the 2012-2013 financial year comprised 10% of all admissions and represented nearly 16% of overall bed days (Table 1.1)[7]. Despite the large proportion of presentations and admissions represented by this age group, the underlying causality for presentation other than the allocation of international classification of disease (ICD) codes has not been explored. The Australian Institute of Health and Welfare in the publication of Australian Hospital Statistics 2012-2013 reported a large increase in separations (hospital discharge) and bed days for patients aged less than one year[8]. The separations measured per 1000 (male 600:1000 and female 500:1000) population were two to three times greater than other separations within the paediatric population[8]. Infants are a vulnerable population, where all aspects of their care are out of their control, especially in the hospital environment.

Table 1.1 Admission to Royal Children's Hospital (Brisbane) by age group 2012- 013

Age Group (years)	Number of Admissions	Percentage of Total Admissions (%)	Number of Overall Bed Days	Percentage of Overall Bed Days (%)
0-1	2,008	9.9	8,049	15.9
1-5	7,331	36.4	15,169	30.1
5-10	5,612	27.9	11,828	23.4
10-16*	5,198	25.8	15,444	30.6
Totals	20,149	100	50,490	100

*This includes 236 Admissions and 707 Bed Days for patients who were transitioning to adult care
Source: Royal Children's Hospital 2013

Definition

Presentation to hospital is where an infant is either brought to the hospital by parents or transferred from regional areas, interstate or inter-country to the emergency department seeking care. The Australasian Triage Scale (ATS)[9] is initially used to assess the severity of the reason for attending. Following medical assessment and possible initial treatment within the emergency department a decision is made as to whether the infant needs hospital admission for ongoing treatment or is well enough to return home. Infant hospital admission is usually either an emergency admission (via the

emergency department (ED)) or an elective (planned) admission for either a surgical or medical intervention.

1.2 Infant feeding and infant presentation and or admission to hospital.

An association with infant feeding, which could be breastfeeding, formulated milk or complementary food, is often overlooked amongst the primary reasons for presenting to a paediatric hospital. Optimal infant feeding via breast milk is said to reduce the incidence of disease by contributing to both the passive protection and the development of the immune system of the infant[2,3,10] and improve long-term health outcomes[4,11,12].

Acknowledging then, that sick and vulnerable infants have the most to gain from optimal feeding there is a paucity of literature specifically on infant feeding in the paediatric hospital environment[5]. The exception to this is pre term infants where the benefits of breast milk are well reported[6,13,14]. Previous studies in the area of infant feeding and hospitalisation have had a primary purpose of assessing the risk and benefits of the type of infant feeding in relationship to illness, traditionally comparing health outcomes among breastfed infants against a reference group of formula fed infants[15]. In developing countries, studies have shown a proven definitive causal effect of feeding type on morbidity and mortality in infancy, specifically in the instance of the protective effect of breastfeeding in prevention of gastroenteritis[11,16-18]. Studies in developed countries have been attempting to demonstrate the same effects for many decades with contradictory findings. Taylor[19] in one of the earlier studies noted the potential impact of sociodemographic variables in relating feeding type to prevention of illness. Kovar[20] in a review of the epidemiologic evidence for an association between infant feeding and infant health examined specific issues within the overall context of the apparent influence of breastfeeding on diseases including severity of the disease, protective effect, socioeconomic and demographic variables and duration of the protective effect post breastfeeding. Studies have continued to examine these issues with inconclusive evidence. Bachrach and colleagues[21] suggested that the magnitude of breastfeeding "benefit for healthy infants with high standards of living is not well delineated". The report by Ip et al[11] of "Breastfeeding and maternal and infant health outcomes in developed countries" prepared for the Agency for Healthcare Research and Quality in the USA, reviewed the evidence on the effects of breastfeeding on short and long term infant and maternal health outcomes in developed countries. This review found that a history of breastfeeding was associated with a reduction in the risk of acute otitis media, non-specific gastroenteritis, severe lower respiratory tract infections, atopic dermatitis, asthma in young children, obesity, type 1 and 2 diabetes, childhood leukaemia, sudden infant death

syndrome (SIDS) and necrotizing enterocolitis. The authors of this review did caution on basing causality on these findings, as most of the studies reviewed were observational and of varying quality across the health outcomes. Some studies have also measured breastfeeding early in life and attributed the effects to longer-term health outcomes such as obesity, cardiovascular risk factors[22-24].

The reasons for an infant presenting and or being admitted to a hospital are varied; with predominate reasons reported as respiratory illness, gastrointestinal illness, and jaundice[11]. Studies relating to infant feeding and hospitalisation, although small in number, generally reflect this. No studies have addressed surveillance of previously hospitalised infants for growth and development. The implications of complementary feeding in relationship to ill health in infants have not been explored within the context of feeding and hospitalisation.

The World Health Organization (WHO) definitions of breastfeeding[25] (Table 1.2) categories are commonly referenced as the method used in studies to define feeding within that study. The difficulty is the interpretation of these definitions by researchers, with little consistency in reporting across data collections[21,26-28]. Bachrach[21] describes this as simplification of authors' consideration of breastfeeding by minimising its exploration.

Table 1.2 World Health Organization criteria that define selected infant feeding practices

Feeding Practice	Requires that the infant receive	Allows the infant to receive	Does not allow the infant to receive
Exclusive breastfeeding	Breast milk (including milk expressed or from a wet nurse)	ORS, drops, syrups (vitamins, minerals, medicines)	Anything else
Predominant breastfeeding	Breast milk (including milk expressed or from a wet nurse) as the predominant source of nourishment	Certain liquids (water and water-based drinks, fruit juice), ritual fluids and ORS, drops or syrups (vitamins, minerals, medicines)	Anything else (in particular, non-human milk, food-based fluids)
Complimentary breastfeeding	Breast milk (including milk expressed or from a wet nurse) and solid or semi-solid foods	Anything else: any food or liquid including non-human, milk and formula	NA
Breastfeeding	Breast milk (including milk expressed or from a wet nurse)	Anything else: any food or liquid including non-human, milk and formula	NA
Bottle-feeding	Any liquid (including breast milk) or semi-solid food from a bottle with nipple/teat	Anything else: any food or liquid including non-human, milk and formula	NA

Adapted from: World Health Organization (WHO) 2008[25]

Irregularities in consistency of data have led to sometimes controversial and contradictory findings in relation to infant feeding and reasons for hospitalisation. In previous studies prevalent methodological limitations exist, including: lack of specificity of type of feeding category, lack of detailed clinical definition of what constituted clinical diagnosis, with lack of identification of breastfeeding exposure immediately prior to the onset of illness or confounding factors[20,26,29-31].

In developed countries, as mentioned previously, there have been mixed findings of the importance and benefits of breastfeeding between studies[32-34]. Leung[33] and Tarrant[34] both drew data from a prospective birth cohort study in Hong Kong in 1997. Tarrant found just over 3% of infants were admitted for respiratory infection (243/7781) in the first 3 months of life. Forty three percent of the mothers (3342) in this study, which is a very low number, initiated breastfeeding, with just over a third giving breast milk and formula during the first three months and six percent exclusively breastfeeding. It is therefore difficult to make an inference from these data on the benefit of breastfeeding and a reduction in morbidity from respiratory infection. Leung and colleagues [33] using the same data, found that for all illness categories combined (including respiratory tract infection and gastroenteritis (univariate analysis not reported for respiratory tract illness)), with any breastfeeding (mixed or exclusive) there were increased hospital admissions in the first 18 months

of life. Although this is surprising, Leung explained that jaundice predominately accounted for the increased hospitalisation of breastfed infants especially in the first 3 months of life[33]. Exclusively breastfed infants for ≤1 month appeared more likely to have been hospitalised but the authors noted, "the estimates within strata of breastfeeding are rather imprecise"[33] . Lademenou and colleagues[32], in a study of 926 infants in Crete, found that infants exclusively breastfed for 6 months after adjustment was associated with fewer infectious episodes for acute respiratory infection (OR 0.58, 95% CI 0.36 to 0.92), acute otitis media (OR 0.37, 95% CI 0.13 to 1.05) and thrush (OR 0.14, 95% CI 0.02 to 1.02). Lademenou and colleagues[32] found that partial breastfeeding was not related to a protective effect; however prolonged exclusive breastfeeding was associated with fewer infectious episodes and fewer admissions to hospital.

The linking of recording of feeding and growth history, at presentation and/ or admission to hospital of infants has previously not been made to studies of infant feeding and hospitalisation. Malnutrition has been identified as a problem in hospitalised children especially infants[35-39] with nutritional assessment scores and screening tools being derived to address this situation[40-42]. The recording of infant feeding history in the hospital setting is an important initial step in identifying if the nutritional status of the infant is related to the causality of the reason for presentation and/ or admission or if the reverse is true, that the presence of the reason for presentation and or admission as being the precursor to an infant's feeding problems.

1.3 Thesis Aims

With the increasing level of knowledge of the importance of nutrition in early life there is a need for improved understanding of an infant's feeding history in conjunction with the medical history on presentation and/ or admission to hospital. The focus of this study is to identify, explore and clarify the infant, maternal and sociodemographic factors that may influence feeding before the infant presents to hospital, identify recording of growth and feeding at hospital, the impact of feeding on the reason for presentation and the factors that affect infant feeding in hospital.

Aims

1. To identify and summarise the evidence regarding the extent to which infant feeding may influence hospitalisation for illness in infants.

   H_o = Infant feeding is not related to the reason for presentation and/ or admission to hospital, that there will be no statistical difference between breast and formula feeding in reduction of the number of infants presenting and or admitted to hospital in a systematic review of the literature.
2. To identify the recording of infant feeding history in the medical record of an infant who presents and/ or is admitted to hospital.

   H_o = Infant feeding history will not be recorded in the medical record of infants who present and or are admitted to hospital.
3. To identify the recording of growth in the medical record of an infant who presents and/ or is admitted to hospital.

   H_o = Growth will not be recorded in the medical record of infants who presents and or are admitted to hospital.
4. To establish if a relationship exists between feeding and sociodemographic characteristics and disease type of infants who present and/ or are admitted to hospital.

   H_0 = There will be no difference between breastfed or not breastfed infants, sociodemographic factors and disease type of Infants who present and/ or admitted to hospital.

5. To establish if a relationship exists between breastfeeding duration and the reason why infants present and/ or are admitted to hospital is first noticed.

   H_0 = In the group of infants admitted to hospital infant feeding duration is not related to when the reason for presentation and/ or admission to hospital is first noticed.

Understanding more broadly an infant's feeding history since birth and how feeding and growth are assessed and recorded in the hospital environment is essential to develop strategies to optimise nutrition and growth in this group of children who present and or admitted to hospital.

1.4 Structure of the thesis

The bulk of this thesis is presented as a series of papers. At the time of submission, three papers have been published in the peer review literature and two are submitted for publication. The thesis begins by providing a background on infant presentation and/ or admission to hospital and infant feeding. This background, coupled with research objectives and thesis structure, constitutes the introductory chapter (Chapter 1) and Chapter 3 presents the research design and methodology.

Following the introduction, Chapter 2 focuses on describing from the literature, infant presentation and/ or admission to hospital, infant feeding and factors that have been associated with infant feeding. This includes the predominant reasons for presentation and/ or admission of infants to hospital previously reported in studies and studies of audit within a paediatric setting. The literature review informed the development of a systematic review of infant feeding experience and hospitalisation in developed countries (Chapter 4), which examines whether the mode of feeding is associated with the risk of hospitalisation for illness during infancy. The electronic literature search identified 187 articles of which six studies met inclusion criteria with a primary outcome of hospitalisation or feeding type with a comparator. The combined number of infants in the selected studies was 272566, with cohort sizes ranging from 926 to 248077. Studies consistently reported a univariable association between breastfeeding and reduction of infant hospitalisations; however, the association between duration of feeding and hospitalisation was more ambiguous. (A systematic review of infant feeding experience and hospitalisation in developed countries. Acta paediatrica 2014; 103:131-138).

Following the review of the literature it became apparent that the feeding history of the infant and growth monitoring were infrequently mentioned in studies of infants who presented and or were admitted to hospital. Therefore a retrospective chart audit was designed to identify if firstly, the recording of feeding history (Chapter 5) had occurred and secondly, the recording of growth (Chapter 6) of infants presenting and or admitted to a paediatric hospital. The chart audit comprised of 465 hospital charts of infants who had presented to the emergency department in the financial year 2011-2012 at The Royal Children's Hospital Brisbane. Chapter 5 reports the findings of the audit of feeding documentation in a paper, 'Hospital, infants and feeding: the importance of audit' (Journal of Paediatrics and Child Health 2015). This paper found that a comprehensive feeding history is not recorded on many occasions; with infant age significantly associated with less frequent recording of feeding mode, type, frequency and changes. Chapter 6 reports the findings of the audit of infant growth documentation in a paper 'Back to basics: an audit of measurement of

infant growth at presentation to hospital'. (Australian Health Review 2015). This paper found that infant measurements of growth, that being weight, length and head circumference were not recorded on many occasions and that age of the infant was significantly associated with recording of birth weight.

The systematic review finding that the association between duration of feeding and hospitalisation was unclear, along with the knowledge from the chart audit that there was poor recording of infant feeding and growth in this hospital setting, clarified the questions for the next phase of the study. In Chapter 7, the questionnaire phase of the study focuses on identifying pre presentation feeding history and the reason for presentation and/ or admission associated with sociodemographic data. Three hundred and thirty five parents of infants who had either presented and/ or had been admitted to the Royal Children's Hospital Brisbane agreed to complete the questionnaire with the interviewer during a six month period between March and October 2013. The findings from this phase of the study were that breastfeeding and infant characteristics may influence infant presentation and or admission to hospital, with a protective effect of breastfeeding reducing infection in some diagnostic categories. (Characteristics of infants who present to a paediatric hospital: feeding history, submitted for publication).

In Chapter 8, the admission phase of the questionnaire, the focus was to explore what factors contribute to a potential feeding change of infants either before or during the hospital admission. Breastfeeding duration was significantly associated; mothers with older infants (26-52 weeks) less likely to breastfeed their infants. Although, hospitalised infants were breastfed or receiving breastmilk from their mother in the over 26 week age group in a similar rate to that found in the wider Australian population. Maternal health and the hospital experience for infants require further exploration to promote optimal nutrition for hospitalised infants.

The overall findings of the thesis are discussed in Chapter 9, including recommendations for future practice and research.

The appendices include copies of the ethical approval documents obtained from both The University of Queensland Medical Research Ethics Committee and the Queensland Children's Health Services Human Research Ethics Committee, and the Site Specific approval from Queensland Health. The parent information statements, consent forms, chart audit form and questionnaires, are included.

CHAPTER 2 LITERATURE REVIEW

2.1 History of infant feeding

Breastfeeding is acknowledged as the optimal infant nutrition[12]. However, not all women are able or wish to breastfeed and a significant proportion of infants receive some infant formula in their first year of life. Artefacts found in Egypt and the near East dated back as far as 3000BC are evidence of artificial feeding methods in early times[43]. Much later in the second part of the eighteenth Century, artificial feeding was discussed by a small number of medical writers who viewed it as a dangerous and a frequently fatal undertaking and recommended artificial feeding only when absolutely necessary. Substitute infant feeds were commonly bread and water 'pap'[43]. Fomon[44]and Weaver [45] described the use of commercially prepared formulas which were patented. Liebig's food for infants in Scotland was one of the first in 1867, which was firstly produced as a liquid then in powdered form, consisting of wheat flour, cow's milk, malt flour and potassium carbonate[45]. In English textbooks post 1900, wet nursing was recommended as a last resort for a sick child who was artificially fed. Although there were problems involved in finding and employing a suitable woman[43], thus acknowledging that infant formula was not a healthy choice. Evaporated milk, in cans, came into use as an infant food in the 1920's; it was inexpensive, could be stored at room temperature and was free of bacterial contamination until opened. From the 1930's formula's fed to infants were commonly prepared with a combination of evaporated milk or fresh cow's milk, water and a carbohydrate (typically a corn syrup in the USA)[44].

Composition of Formula

Problems then unrecognised of formula feeding were the high potential renal solute load, low iron content with a high intake of inhibitors of iron absorption, increased intestinal blood loss attributed to whole milk formulas, low intake of essential fatty acids and scurvy, however these issues were often not recognised[44]. A belief from as early as the 1930's was that human milk had a higher protein concentration than formula and that infants fed formula needed a greater intake of protein than did breast-fed infants. From this emerged the resultant two classes of commercially prepared formula; one a formula similar to the home prepared, evaporated milk formula with added vitamins and the other had a lower protein content and contained a mixture of vegetable and oleic oils with added vitamins and minerals[44]. Fomon[44] suggested that the takeover of the market by the lower protein content formula type was related to the smell of regurgitated butterfat from the first type of

formula and its potential link to constipation, rather than consideration of nutrient requirement or renal solute load. Many formulas were available with an undesirable high renal solute load. This is important in terms of the analysis of health outcomes as many of the few studies on infant feeding and hospitalisation are from last century when high solute loads were still permitted[44]. By the mid 1960's most formulas had the same composition, some with iron fortification, which had been introduced in the USA in 1959. However, iron fortified formula was perceived to be responsible by many parents and physicians for constipation, fussiness and intestinal disturbances in infants[44].

In the second half of the 20th century as formulas evolved, with research supporting their efficacy, formula use increased and consequently breastfeeding rates steadily declined[44].In response to declining breastfeeding rates, unregulated marketing of breast-milk substitutes, and the potential effect of artificial feeding on infant morbidity and mortality, the World Health Organization (WHO) International Code of Marketing of Breast-milk Substitutes (WHO Code) was adopted by 118 member states at the 34th World Health assembly in 1981[46]. This code was formulated with the aim of contributing to "the provision of safe and adequate nutrition for infants by the protection and promotion of breastfeeding, and by ensuring the proper use of breast milk substitutes, when these are necessary, on the basis of adequate information and through appropriate marketing and distribution" and was adopted as a recommendation rather than as a regulation[46]. Australia has the Marketing in Australia of Infant Formulas: Manufacturers and Importers Agreement (MAIF) as a voluntary code in operation, which covers all articles of the WHO Code and this agreement is formally monitored[47].

Early infant feeding

Infant feeding is now delineated by breastfeeding versus formula feeding with the associated implication of 'good mothering' attached to breastfeeding mothers[48]. Breastfeeding initiation rates have increased in developed countries following the introduction of the United Nations Children's Fund (UNICEF) sponsored Baby Friendly Hospital Initiative (BFHI) in hospitals worldwide with subsequent education of health professionals to the benefits to mother and infant of breastfeeding[47]. Despite official guidance about infant feeding many mothers continue to introduce formula into an infant's diet in the early weeks following birth[48,49]. The reasons for introducing formula include perceived insufficient milk supply, breast engorgement, nipple pain and trauma, and mastitis. The failure of targeted pro breastfeeding initiatives to succeed in increasing breastfeeding rates, especially that of duration, occurs as they fail to address the socio economic and cultural issues

determining living conditions and therefore infant feeding practices, particularly of working class women[48].

Recently feeding style (traditional compared to baby-led breastfeeding) is becoming recognised as potentially leading to later obesity with two areas of interest being self-regulation of milk intake and satiety[50] and secondly, maternal controlled feeding styles in infants in their first six months of life of either breast milk or formula feeds[51 52]. An important issue for mothers choosing to formula feed is the difficulty in obtaining health professionals advice since the introduction of the Baby Friendly Hospital Initiative. The maternal advice sought is guidance on which formula to choose, attainment of knowledge to safely prepare the formula and 'the do's and don'ts' of formula feeding which can be considered problematic in relation to infant health[48].

Breastfeeding

The authors of 'A Guide to the Care of the Young Child' Seventh edition printed in 1972, stated in a chapter on breastfeeding, "The advantages of breastfeeding are apt to be overlooked. We are strongly of the opinion that these advantages are real and where possible the baby should be breast fed. The incidence of breastfeeding in any community depends on the attitude of the public to it. The doctors and nurses in contact with mothers and babies by stressing the desirability of breastfeeding can create the demand."[53]

The book that replaced this 'guide' in 1986, the first edition of 'Infant and Family Health in Australia' was published. In the chapter on breastfeeding in this book it was written that "it is often social circumstances which have a far greater bearing on when weaning takes place and continue with "some women lactate against family opposition and they may be under constant subtle, or not so subtle pressure to discontinue."[54]

2.2 Breastfeeding definitions

In many studies, breastfeeding can only be described as 'ever versus never' from the available data. Importantly, the review by Bauchner and colleagues[29] of breastfeeding and infection in 1986 highlighted inconsistencies with data collection surrounding infant feeding. Bauchner and colleagues[29] applied four methodological standards, which entailed detection bias, adjustment for potential confounding variables, definition of an outcome event and definition of breastfeeding. While studies attempting to conform to these standards and the more recent World Health

Organisation definitions of breastfeeding[25] do exist, authors have interpreted these standards and definitions for their study populations differently, consequently difficulties remain with generalizability across population groups in determining the effect of breastfeeding or not on infant health. A Cochrane review of optimal duration of exclusive breastfeeding by Kramer and Kakuma in 2012[18], concluded that infants who are exclusively breastfed for six months experience less gastrointestinal morbidity than infants fed exclusively for three to four months. This review found no reduced risks of other infections, allergic diseases, obesity, dental caries, or cognitive or behaviour problems had been demonstrated. The maternal benefit of exclusive breastfeeding for six months was prolonged lactational amenorrhoea.

2.3 Breast versus Formula feeding

An international comparison study into the implementation of the WHO Code and other breastfeeding initiatives found that it is widely accepted that the decline in breastfeeding rates over the first half of the 20th Century in developed countries "was related to the medicalisation of birth, the influence of medical advice and the introduction of infant formula."[47]. While this is true, it does not take into account the preceding history of formula in relation to infant health.

Within the literature, discrepancy exists about the portrayal of infant feeding. McNiel and colleagues[55] stated that "analytical approaches to the study of infant feeding rarely set exclusive breastfeeding as the norm with which any other feeding approach should be compared" which they found inconsistent with the accepted use of the proved optimal treatment approach (breastfeeding) as the standard or control group in research design. Further to this, Smith and colleagues[56], in a systematic analysis of publication titles or abstracts, found that titles of infant feeding studies are misleading and imply that there is a risk associated with breastfeeding as the experimental or deviant behaviour as opposed to that of formula feeding; stating that "formula feeding was rarely named as an exposure increasing health risk in publication titles or abstracts".

2.4 Formula feeding

Lee[48] stated that women who use formula milk to feed their infants have been widely studied for the purpose of identifying the reasons for the gap between official advice and maternal behaviour. A systematic review by Lakshman and colleagues[57] supported these findings, that formula feeding mothers had been studied extensively, but in the context of their reasons for not breastfeeding. The review identified issues with hygiene and safety in the preparation of formula feeds, reconstitution

issues, no exploration of how much formula milk to give or how often to feed and concerns relating to formula change. The discussion of the review highlighted that mothers who bottle fed experienced a number of negative emotions including 'guilt, anger, uncertainty and a sense of failure.' It is important to ensure that formula milk is prepared and administered safely and correctly, with healthcare providers ensuring the needs of formula feeding parents are not overlooked, including reassurance to mothers that bonding, attachment and infant health are not irreversibly damaged[57]. The National Health Service (NHS) in the UK offers 'Start 4 Life' which provides bottle-feeding advice for parents, with an NHS Choices updated guide to bottle feeding leaflet available[58]. In Australia, there appears to be no equivalent information available from government agencies, other than the National Health and Medical Research Council Infant Feeding Guidelines released in 2013[59].In summary the guidelines present information on encouraging, supporting and promoting breastfeeding in the Australian community, initiating, establishing and maintaining breastfeeding and common problems of breastfeeding and their management. The formula feeding information in these guidelines covers the composition, preparation and use of infant formula and special infant formula. The final sections in the guidelines are on introducing solid food and Interpretation of the WHO Code for health workers in Australia.

2.5 Introduction of solid food-complementary food

Infancy is a time of transition from a milk diet (either breast or formula) to a varied diet from all food groups being consumed on a daily basis by most infants[60]. The World Health Organization recommends the introduction of solids at six months of age, with the European Food Safety Authority, following a recent expert review, concluding that for infants across the European Union, complementary foods may be introduced safely between four and six months[61] The Australian Infant Feeding Guidelines 2012 states "introducing solid foods at around six months is necessary to meet the infant's increasing nutritional and developmental needs". Little is actually known about infant feeding patterns of solid food and potentially associated illness in developed countries. Studies designed to assess the association between infection rates and the age of introduction of complementary food in both formula and breast-fed infants are scarce[61].

Data from the UK Infant feeding survey 2005 found that less than 1% of parents were following the recommendation to exclusively breastfeed for 6 months[62]. However, a trend towards later introduction of solids was reported at this time, which was attributable to a shift in the proportion of mothers commencing weaning between 4 to 5 months, rather than the advice of two years previous to exclusively breastfeed for 6 months[62]. Six months of exclusive breastfeeding may not always

provide sufficient nutrition for optimal growth and development[61]. Grummer Strawn and colleagues[60] analysed data from a 7-day food recall chart administered every month until 12 months of age as part of the Infant Feeding Practices Study II, to identify the time of transitions in infant feeding. An important finding of this study was that infants who were initially breastfed were far more likely to have solid food introduced after 4 months, than those who were fed formula from birth. Infant cereal was usually found to be the first food, with fruits and vegetables introduced at a median age of 5 to 6 months with meats introduced at a median age of 8 months[60]. A contemporary Australian study found that by 4 months of age 21% of mothers had introduced non-milk foods to their infants. As Grummer Strawn and colleagues had found infant cereal was the predominant first food in this study[63].

Introduction of complementary food to infants and the development of allergy has also caused debate. The advice on the timing of the introduction of complementary foods was changed by the Committee on Nutrition, Section on Allergy and Immunology of the American Academy of Pediatrics in 2008[64], and by the section on Paediatrics of the European Academy of Allergology and Clinical Immunology also in 2008[65] and the ESPGHAN Committee on Nutrition[66]. Agreement was reached that there was no "convincing scientific evidence that avoidance or delayed introduction of potentially allergenic foods beyond 4-6 months reduces allergies in infants considered an increased risk for the development of allergy or in those not considered to be at an increased risk"[61] .Langley Evans in 2014 proposed that "there is an overwhelming body of evidence to demonstrate that nutritional influences encountered during early life have a lasting impact upon health and well-being". Identifying that the infant diet is important, a body of evidence has given cautious support for the idea that breastfeeding and delaying the introduction of complementary foods until beyond 4 months of age may protect against overweight in childhood[67]. Koletzko and colleagues[23], as editors, commentary in Nutrition and Growth Yearbook 2014 state that "in contrast to the large literature on breast and formula feeding, little attention has been paid to the complementary feeding period, the nature of the foods given, or whether this period of significant dietary change influences later health and development. The limited scientific evidence base is reflected in considerable variation in complementary feeding recommendations between countries." The literature on complementary feeding and presentation and or admission to hospital has had even less attention. There is a knowledge gap in relation to complementary infant feeding and health, especially that of hospitalised infants.

2.6 Alternative feeding

There is much literature on alternative feeding of preterm infants including enteral feeding and cup feeding and also the use of expressed breastmilk, kangaroo care and non-nutritive sucking in the intensive care and special care nursery setting, in maternity hospitals. Yet again, there is a paucity of literature as regards infants who are hospitalised and receiving nutrition from alternative methods of infant feeding in the paediatric setting. The alternative forms of feeding in a paediatric setting require either vascular access or are enteral feeds. Vascular access in the form of peripheral intravenous lines is used for fluid depletion or central venous access for total parenteral nutrition. Enteral feeding may initially be a nasogastric tube but some infants may require a longer term solution to feeding such as insertion of a gastrostomy tube.

2.5 Presentation to hospital and infant feeding

Data relating to infants presenting to hospital in previous studies have been linked to clinical diagnoses and admission to hospital in many studies[19,68-70]. One such study in the UK found that the top five clinical diagnoses of infants who attended accident and emergency departments were 'infectious diseases', 'gastrointestinal', 'respiratory', 'unclassifiable', 'other' and 'no abnormality detected'[68]. There was a range of more specific diagnoses within each of the diagnostic categories. The infectious disease category included for example, malaria, meningitis and measles and the respiratory disease category including pleural effusion, croup and viral induced wheeze. 'Unclassifiable', included paediatric parental concern; and 'gastrointestinal' diagnoses including feeding problems, infantile colic, jaundice and failure to thrive with 'other' including head injury, laceration and allergy[68]. This study suggested that their findings "highlights the importance of recording a clear diagnosis for an over represented vulnerable group of children attending accident and emergency". While concern is expressed by the authors about ensuring recording a clear diagnosis, it is also important to recognise that these five diagnostic categories described may have feeding and or growth implications for the infant. Nevertheless, there is a paucity of studies that firstly present infant data and secondly feeding and growth data within the infant population who present to an accident and emergency department in developed countries where infants are known to be an over represented group[68,71,72].

Medical admission and feeding

Decreases in appetite, nutrient intake, physical activity and weight loss are common features of acute illness; despite this, the nutritional status of hospitalised infants is infrequently mentioned in studies pertaining to hospitalised infants[73]. A reduced energy intake may be the cause of nutritional requirements not being met and alternatively an increased resting energy expenditure due to fever may be causal; while proven in the adult population, this has not been confirmed in the paediatric setting[73]. Wiskin[73] suggested that determining the reason for unmet nutritional requirements is "of real clinical relevance because it may determine the timing and type of nutritional intervention offered to children with poor dietary intake associated with infectious disease". Wiskin and colleagues[73] emphasise the need for an understanding of the energy and nutrient requirements of the ill child to ensure that infants "receive adequate nutritional support to facilitate recovery from illness and optimise long term growth."

Surgical admission/accidental injury and feeding

There are limited studies of surgical admission, accidental injury presentation or admission of these infants and any relationship with feeding mode. Head trauma in infants from falls is reported to be the most common accident scenario in young children as well as the most common history provided in child abuse cases[74]. In a study by Ruddick[75] feeding problems such as not tolerating feeds was a symptom noted as suggestive of underlying brain injury. Injury can occur from intubation such as contusion or laceration of the tongue, gum, pharynx, epiglottis, vocal cords or oesophagus. The infant may have possible low body weight at surgery (from being ill), the effect of anaesthesia, the type of surgery, for example such as cleft palate repair, all have the potential to lead to postoperative feeding difficulties, but again there is a paucity of studies in the area of surgical admission, accidental injury and infant feeding.

Infants with feeding difficulties

The extremely complex process of an infant developing feeding skills is reliant upon multiple anatomic, neurophysiologic, environmental, social and cultural factors[76]. When feeding difficulties and illness occur simultaneously, there is a dearth of literature describing the details of infant feeding difficulties and their relationship, if any, to presentation and or admission to hospital. Wallis and Harper[77] wrote that "the majority of knowledge about breastfeeding pertains to healthy

term babies or the sick pre-term baby" and that "information about babies with specific difficulties or congenital abnormalities is not always easy to access"[77].

Maternal factors and infant feeding

McDonald and colleagues[78] suggest that in health research the general focus is "on the mother or the baby, (with the mother becoming lost)". Maternal health is rarely reported in studies of infant feeding and even less so in studies of infant health. Maternal sociodemographic factors have been recognised as influential in infant feeding choice, although very few studies have explored maternal health and its relationship to infant feeding outcomes. Maternal health and diet is increasingly recognised as impacting on infant outcomes with recent studies evaluating maternal diet during pregnancy and breastfeeding on infant metabolic programming[23,79], epigenetics[80] and fuel mediated teratogenesis beyond birth[81,82]. With Crume and colleagues[81] findings suggesting that breastfeeding may reduce the increased risk of childhood obesity in the infants of mothers with diabetes during pregnancy. The effect of maternal obesity has also been reviewed in relation to breastfeeding outcomes[83-85] with overweight and obese mothers intending to breastfeed for a significantly shorter period of time[84], less likely to initiate breastfeeding and to breastfeed for a shorter duration[83-85]. Maternal caloric restriction and exercise during lactation in affluent populations has also been identified as an important area of research[86]. Dewey suggested that there might be a threshold effect of negative energy balance on lactation, where milk output is affected only when energy restriction is severe.

Pre-existing or emergent psychiatric conditions also influence the choice of infant feeding with Grote and colleagues[87] finding that approximately 10-15 % of women experience depression within 12 months of delivery. Postnatal depression is associated with shorter breastfeeding duration[49,88 87], increased breastfeeding difficulties and decreased levels of breastfeeding self efficacy[88].

Diagnosed and undiagnosed disorders including inadequate glandular development, obesity, thyroid dysfunction, Sheehan's syndrome, polycystic ovarian disorder, retained placental fragments, breast surgery (especially breast reduction) and maternal medications can affect a mother's ability to produce and maintain a milk supply[89], along with the potential detrimental effect on her own health. In the Queensland Health, 'Infant Nutrition Survey 2009' Harrison and Hunter in a 2008 survey of biological mothers (n=1200) with children <13 months of age found that 22.5% had chosen to formula feed because of maternal health reasons[90]. Li and colleagues[91] from the participant data of the Infant Feeding Practices Study in the USA found that on average 13% of mothers ceased

breastfeeding due to their own illness and having to take medication. Other factors included being young, unmarried, primiparous, less educated, and poorer and geographic location were each associated with early discontinuation of breastfeeding[91].

There have been numerous studies of some maternal factors including the effect of environmental tobacco smoke exposure on the infant. These studies include that of Di Franza and colleagues[92], from a review of the literature link environmental tobacco smoke exposure to decreased lung growth and increased rates of respiratory tract infections, otitis media, sudden infant death syndrome amongst others. Amir[83]found that women in lower socio economic indexes factor analysis tertile were less likely to breastfeed and more likely to smoke; and as a formula fed infant more likely to become ill. Chantry and colleagues[2] and Duijits and colleagues[93] supported these findings. Whereas, Lademenou[32] reported that exclusive breastfeeding "seemed to significantly protect against total infectious episodes in infants with environmental tobacco smoke exposure". Other maternal factors such as caffeine consumption that may affect infant health[94] (Berlin, Denson 1984) have infrequently been studied.

Infant factors leading to breastfeeding cessation

Infant causes of insufficient maternal milk supply include: an inadequate milk transfer leading to decreased production, prematurity (including near term), illness, Trisomy 21, cleft lip or palate, other anatomic or neurological abnormalities leading to a decreased suck and severe jaundice[89]. Colvin[95] found that children born with birth defects are more likely to be admitted for reasons other than that of a birth defect, with admissions far higher than that of children with congenital abnormalities.

Li R et al[91] from the participant data of the Infant Feeding Practices Study in the USA found that within the first month of life 9.5% of infants were weaned due to becoming sick and could not breastfeed based upon maternal report with an average of 6 % over 12 months. The duration and timing of the infant's illness may determine the mother's ability or choice to express breast milk and then progress to breast-feed her infant.

2.8 Summary

This literature review has highlighted that there are a paucity of studies in relation to infant feeding and hospitalisation. In recognising the significant findings of previous research in this area, particularly that of infectious episodes in relation to type of infant feeding, there remains large gaps. This study aims to identify, explore and clarify relationships between feeding, presentation and or admission to hospital, maternal and sociodemographic factors and enhance what is known. While studies of preterm infants consistently report the importance of nutrition for growth and development, it is of equal importance to address the issue of nutrition in infants who present and or are admitted to hospital at a critical time in their development to ensure optimal healthcare.

CHAPTER 3 RESEARCH DESIGN AND METHODOLOGY

3.1 Research Strategy

The two original research components of this study were an audit and a face-to-face questionnaire survey.

3.1.1 Audit

Study Design

A retrospective chart audit at the Royal Children's Hospital (RCH) in Brisbane, Queensland, occurred during October to December 2012.

Setting

The RCH was a tertiary paediatric hospital with approximately 25000 (0-15 years) presentations annually to the emergency department. Records were selected for audit using computer - generated random numbers. To obtain a representative proportion of charts to reflect seasonality presentations, a systematic random sampling of approximately 10% of each month's presentation of infants' charts were audited. The charts were reviewed within the Health Information Management Service at RCH. The infant charts were not selected for audit by category of illness or injury, or whether they had been admitted to capture a representative range of presentation. The data collection form was developed after consultation with medical staff and human information management services staff to best capture the recording of measurements and feeding within charts. The first version was piloted with five charts and minor revisions were made before the audit commenced. Children's Health Services Queensland Human Research Ethics Committee (HREC/12/QRCH/179) and The University of Queensland Medical Research Ethics Committee (Approval Number 2012001150) approved this study (Appendix 1)

Participants

Infant presentations contributed approximately one sixth of this number (4688) in the 2011-2012 financial year. Medical records selected from infants (0-12 months) who had presented to the emergency department between 1st July 2011 and 30th June 2012 were audited.

Outcome variables

Data extracted for the feeding audit were recording of feeding type (e.g. breast, expressed breast milk, formula, cow's milk, solid food) with changes since birth, the mode of feeding (e.g. breast, bottle or tube feeding) and feeding frequency at date of presentation and or admission to hospital, recorded as free text and later categorised. The data extracted for the audit of measurement of infant growth were anthropometric measures (weight, bare weight, length and head circumference) at date of presentation and or admission to hospital. Additional assessment pertinent to nutritional status, such as weight-for- age Z-score, was recorded if documented.

Explanatory variables

Data extracted were date of birth and gender, postcode of residence, recording of diagnosis, gestational age, delivery type, birth weight, birth length and head circumference. Date of presentation and or admission was recorded. A socioeconomic (SES) tertile was obtained for each individual by linking Socio Economic Indexes for Areas (SEIFA) data at the postcode level.

Sample size

Five hundred records were selected for audit. Table 3.1 below shows the power to find a statistically significant between-group difference under different assumptions regarding the proportion of participants in the reference group who achieve the outcome, and the relative difference compared to comparison group participants who achieve the outcome. The possible proportions of participants in the reference group who achieve the outcome of interest are listed as 0.1, 0.3, and 0.5. Relative differences examined are 1.1, 1.25, 1.5, and 2.0. The calculated figure is the power to detect a difference between the reference and comparator groups, assuming alpha=0.05 and that infants are as likely to be in the reference group as they are to be in the comparator group. For example, if we are interested in the association between infant gender and whether feeding type was recorded, and we assume that in the reference group feeding type is recorded on 50% of occasions and also assume there will be as many male and female infants, then we have 80.6% power to detect a relative difference between male and female of 1.25 or greater (ie to detect a significant difference if feeding type is recorded for females on 62.5% or more of occasions).

3.1 Sample size calculation for audit

Proportion of reference group who achieve outcome	Relative difference			
	1.1	1.25	1.5	2.0
0.1	6.5%	14.3%	39.3%	88.1%
0.3	11.1%	42.6%	93.6%	100%
0.5	20.1%	80.6%	100%	100%

3.1.2 Questionnaire

Study design

The questionnaire phase of the study was paper based and completed with the researcher in a structured face-to-face interview with parents and or carers. The data collection method was designed to capture infants across all sociodemographic groups and was not reliant on computer access or written literacy skills and therefore did not need a high level of skill or motivation for participation. The survey method was particularly valuable, as it allows for assessment of verbal and non-verbal responses, reduces non-responses and allows for a more complex survey tool[96].

The survey measurement tool was a 40-item questionnaire (with 6 items as additional questions for admitted infants, including details pertaining to the admission) that contained both fixed-response and open-ended questions about the reason for presentation and or admission to hospital, socio-demographic data and the feeding history from birth. The questionnaire included questions about how the infant had been fed since birth. The researcher recruited and administered the questionnaire that had been piloted among a sample of 5 mothers. The pilot results guided expert review of the survey tool and clarified the conditions required for data collection. If the survey could not be completed at the time of presentation or admission a telephone interview was used to complete the survey within one month of the initial contact.

Setting

The survey phase of the study was conducted from March 2013 to October 2013 at The Royal Children's Hospital a tertiary paediatric specialist centre in Brisbane, Australia. In 2013 there were 24,000 presentations to the emergency department of 0-16 year old children of which 30% were infants aged 0-12 months. Infants who were admitted to the hospital accounted for 16% of overall bed days.

Participants

Parents of infants who presented and/or were admitted to hospital during the six month study period were invited to participate. Participant recruitment took place covering a range of days and time periods, in order to capture a wide spectrum of infants presenting, e.g. as a one-off acute episode or as a frequent presenter with recurrent health issues who presented or were admitted for care. All children aged less than one year were eligible to participate, regardless of the reason for presentation. There were no exclusion criteria. As the study was conducted in a tertiary paediatric facility infants from a wide region presented for care.

Outcome variables

The primary outcome of interest was mode of feeding. This was measured at birth and at presentation and or admission to hospital. It was recorded by carer report. Mode of feeding was responded to using the questions "In hospital after your baby's birth, how was baby fed?" and "How are you feeding your baby now?" and options to answer were "breastfed", "formula" and other. There was also the option to enter specific feed types, such as the formula name.

Explanatory variables

Demographic data collected were: date of birth, infant age at presentation and or admission, gestational age, gender, delivery type, disease duration and birth weight. A socioeconomic (SES) tertile was obtained for each individual by linking Socio Economic Indexes for Areas (SEIFA) data at the postcode level[97]. The social data collected were infant position in the family, maternal and paternal age and education, identification as indigenous, English as a first language, country of origin and details of maternal diet and health. Clinical data collected was disease duration, description of reason for presentation and or admission, admission to special care or intensive care

nursery post birth, maternal identification of infant being a fussy feeder, unsettled or unwell previously and identification of chronic illness. ICD-10 Chapter codes from hospital data were used to identify diagnosis.

Sample size

It was anticipated that three hundred questionnaires would be completed. Table 3.2 below shows the power to find a statistically significant between-group difference under different assumptions regarding the proportion of participants in the reference group who achieve the outcome, and the relative difference compared to comparison group participants who achieve the outcome. The possible proportions of participants in the reference group who achieve the outcome of interest are listed as 0.1, 0.3, and 0.5. Relative differences examined are 1.1, 1.25, 1.5, and 2.0. The calculated figure is the power to detect a difference between the reference and comparator groups, assuming alpha=0.05 and that infants are as likely to be in the reference group as they are to be in the comparator group. For example If we are interested in the association between gender and mode of feeding at admission/hospitalisation, and we assume that in the reference group breastfeeding occurs on 30% of occasions and also assume there will be as many male and female infants, then we have 76.8% power to detect a relative difference between male and female of 1.5 or greater (i.e. to detect a significant difference if breastfeeding proportion at admission/hospitalisation for females is 45% or greater).

3.2 Sample size calculation for questionnaire

Proportion of reference group who achieve outcome	Relative difference			
	1.1	1.25	1.5	2.0
0.1	5.9%	10.5%	25.7%	68.1%
0.3	8.6%	27.8%	76.8%	100%
0.5	13.9%	58.8%	99.5%	100%

Ethical Considerations

Children's Health Services Queensland Human Research Ethics Committee (HREC/12/QRCH/179) and The University of Queensland Medical Research Ethics Committee (Approval Number 2012001150) approved this study (Appendices 1 and 2). Parental participation in the study was voluntary and participants had the right to withdraw from the study without risk of penalty. All

potential participants were given verbal and written information about the process and purpose of the study, and their consent actively sought (Appendix 3). Participant and patient confidentiality was assured. Questionnaires and patient data were de-identified and coded in a manner known only to the researcher. All data paper copies are kept in a locked storage cabinet in a locked room and will be kept for five years. No individual will be identifiable in the final report or any publications or presentations arising from this study. All electronic data are password protected and accessible only to the researcher. No foreseeable physical risks to parents or the infants were envisaged. However, the researcher acknowledges the potential additional stress consenting and participating in the questionnaire phase of the study may pose for some parents. This potential risk was managed by the participant's right to informed voluntary consent, ability to withdraw, and assurance of confidentiality and anonymity. No negative feedback was received regarding the conduct of the study from any participant. All phases of the study were included in the Ethics approval.

CHAPTER 4: SYSTEMATIC REVIEW

4.1 Introduction

The systematic review has explored whether mode of feeding is associated with risk of hospitalisation for illness during infancy in developed countries.

4.2 Manuscript details

The manuscript details are as follows:

Williams LA, Davies PSW, Boyd R, David M, Ware RS. A systematic review of infant feeding experience and hospitalisation in developed countries. Acta Paediatrica, 2014; 103,131-138 doi: 10.1111/apa12477

The manuscript has been reformatted to fit the requirements of the thesis.

4.3 A systematic review of infant feeding experience and hospitalisation in developed countries

L. Alison Williams, Peter SW Davies, Roslyn Boyd, Michael David, Robert S Ware

Abstract

Aim: The review examines whether mode of feeding is associated with risk of hospitalisation for illness during infancy in developed countries.

Methods: Databases were searched for published studies that included the terms ‘infant feeding’ and ‘hospitalisation’.

Results: Six studies were included. Breastfeeding was associated with a reduced risk of hospitalisation and adjusted analyses showed mixed results. There is no clear relationship between mode of feeding and reduction of infant hospitalisation for illness in developed countries.

Introduction

The importance of breastfeeding for infant health is widely known, with global policies endorsing breastfeeding as the recommended standard for infant feeding[12,98,99]. Benefits of breastfeeding in preventing morbidity have been well reported in developing countries[99] especially through the prevention of gastrointestinal and respiratory illness[21,100]. While a strong beneficial association between breastfeeding and many short-term and long-term health outcomes, such as acute otitis media, non-specific gastroenteritis, severe lower respiratory tract infections, asthma in young children, type 1 and 2 diabetes, obesity, childhood leukaemia, sudden infant death syndrome and necrotizing enterocolitis has been reported in developed countries[11], debate regarding the causality of the association continues[13]. Infants who are hospitalised are known to be at greater risk of malnutrition[35,101] and therefore have the most to gain from optimal feeding, yet few studies have focused specifically on the relationship between breastfeeding and hospitalisation[22,69].

Much of the evidence surrounding the effect of breastfeeding is derived from low quality studies, which may be subject to publication bias and confounding, and the true association may be minimal once factors such as maternal education are considered**.** A notable example is the association between breastfeeding and obesity. Based on results such as from Grummer-Strawn and Mei[60], a large observational study of 177,304 children which showed breast-fed individuals were significantly less likely to be obese than formula-fed individuals, Australian infant feeding guidelines[59] and the policy statement of the American Academy of Pediatrics[98], state that breastfeeding is associated with reduced likelihood of obesity. However a recent high-quality publication[102] found that, in a cohort of Belarusian adolescents, those who with increased duration and exclusivity of breastfeeding were more likely to be obese. Given the re-assessment of our knowledge concerning breastfeeding and obesity, it may be time to re-examine other health outcomes previously thought to be associated with breastfeeding. By more fully informing the evidence-base around breast-feeding we will be able to more completely quantify benefits derived from breast-feeding related health promotion efforts.

The aim of this study was to identify and summarise the evidence regarding the extent to which infant feeding influences hospitalisation for illness in infants. We reviewed the published literature on the relationship between mode of infant feeding and hospitalisations, to examine the overall consistency of associations, the contributions of potentially confounding factors and the extent of potential bias.

Methods

Data Sources

Searches were conducted in PubMed (from 1951), CINAHL (from 1982), Embase (from 1966) Web of Science (from 1975), and DARE (from 1994) until 26th February 2013 (Appendix 4). The search strategy included the medical subject heading (MeSH) terms and free text words for 'infant feeding' and 'hospitalisation'. These were combined with search terms to limit the findings to human, the target age group (0-12 months) and English language. The following search terms were used: (breast AND feeding' OR 'formula feeding' OR 'bottle feeding', OR 'solid food') AND ('patient presentation' OR 'patient admission'). Targeted reference screening and electronic author and citation tracking of key articles were performed to identify relevant publications not identified by the initial search strategy. The systematic literature search was performed by one reviewer (AW).

Study Selection

This review focused on studies examining both infant feeding and admission to hospital. The criteria for inclusion were as follows: published prospective or retrospective cross-sectional or longitudinal observational studies that provided data from a comparison group; hospitalisations were recorded in infants; studies were undertaken in developed countries with food secure environments including clean water supplies. Only English language articles were searched and selected in order to reduce potential bias from misinterpretation.

Exclusion criteria included any articles that were reviews, meta-analyses, commentaries, study protocols, and case-control studies, that focused on: low birth weight infants (as designated in studies <2500 gms), preterm infants (less than 37 weeks gestation), newborns (less than one week of age), neonatal intensive care studies, HIV and drug dependent mothers and infants. We also excluded articles that focused on health utilisation, marketing including Baby Friendly Hospital Initiative, 'sample' bags, and those that were not original, peer reviewed research articles (books, conference abstracts, monographs, and technical reports).

Initial article inclusion was made on the basis of a title review and then abstract, followed by full text evaluation of eligibility criteria. Full text reports of all records passing the title/abstract screen were retrieved and independently reviewed by three members (AW, MD and RW) (Appendix 5) of

the research team; disagreements regarding study inclusion were discussed and consensus reached. All eligible studies passing this stage of the screening were included in the review.

Data extraction and Analysis

A predefined tool was used to extract data from included articles. The extraction tool identified and quantified the presence of the following variables: 1) lead author; 2) year of publication; 3) country (i.e. geographical setting of study); 4) sample size; 5) study population; 6) reason for hospitalisation; 7) exposure to breastfeeding; 8) potentially confounding variables included in analysis; 9) crude association between breast-feeding and hospitalisation; and 10) adjusted association between breast-feeding and hospitalisation. The reviewers were not masked to study authorship and differences were resolved through consensus. The primary outcome used in this review was whether or not the child was hospitalised during infancy. Where possible we recorded the reason for hospitalisation. The primary exposure of interest was mode and duration of infant feeding. To obtain further data and clarification to enable standardisation of the presentation of results and to minimise the extent of reporting and publication bias, requests for data were made to corresponding authors of all selected studies.

Data collected across the studies included infant feeding (as described), socioeconomic status, maternal asthma, marital status, smoking, gender, birth order, siblings, birth weight, gestational age, delivery type, maternal age, education and employment, season, childcare attendance and distance to hospital.

The relative risk of hospitalisation for each breastfeeding category, with no breastfeeding as the reference category, was calculated. In studies where relative risk was not reported, we generated relative risk and 95% confidence intervals using reported frequencies.

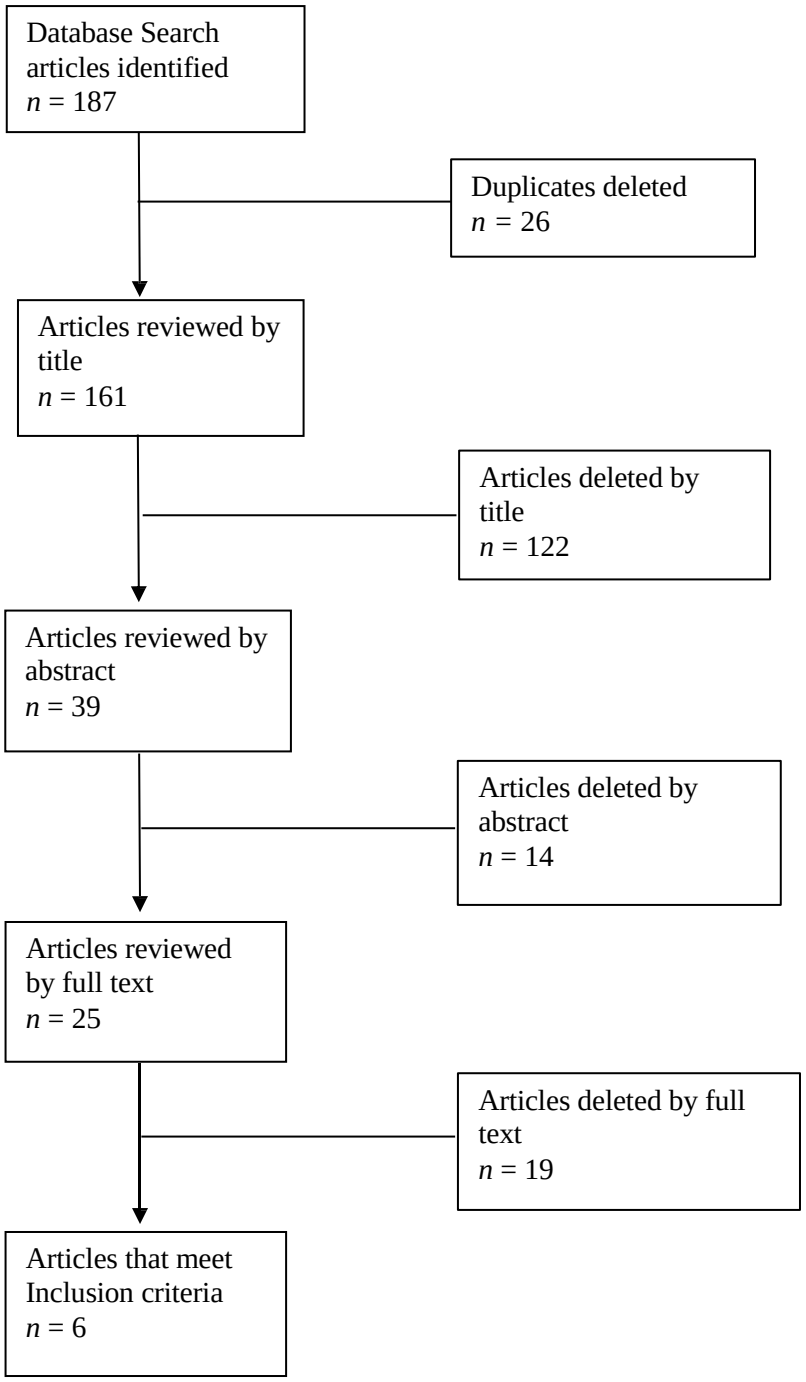
Results

Study Selection

The electronic literature search identified 187 articles, of which 26 were duplicates. A further 122 were excluded by title and abstract because: the primary outcome was not hospitalisation or feeding type with a comparator (*n*= 49); they were preterm infant studies (*n*=22) or they focused on developing countries (*n*=51). A full-text review was undertaken on 25 articles, of which six met

inclusion criteria. Figure 4.1 summarises the results of the search and selection process resulting in the identification of the six eligible studies**.**

Figure 4.1 Flow diagram: Study selection



Study characteristics

The six studies that were selected for review were published between 1982 and 2010, with five published post-2002[22,32,33,69,103] (Table 4.1). One study was set in Australia, two in England and one each in Greece, Hong Kong and Spain. The combined number of infants in the selected studies was 272,566, with cohort sizes ranging from 926 to 248,077. Four studies were nested in existing infant population-based studies[19,22,33,103]. Five of the six authors responded to requests for further data.

Infant feeding information

In all included studies feeding was measured via maternal report. Feeding was measured on either one occasion only: at discharge post birth[22], at six months[69], at 12 months[19,103] or repeatedly: postnatal, one, three, six, and 12 months[32], and postnatal three, nine and 18 months[33]. Five studies recorded duration of feeding[19,32,33,69,103] and two studies recorded exclusivity of breastfeeding[32,33].

Outcome measurement

Hospitalisation was reported overall, for illness, and by reason for admission. One study reported overall hospitalisation[32], one hospitalisation for any illness[33], two for infection[32,69], four for respiratory tract infection[19,22,33,103], two for gastrointestinal illness[19,33], and one for jaundice[33]. The source of hospitalised data was by maternal interview[19,32,33,69,103], and/or review of hospital records[22,69,103]. The length of follow up varied from 12[19,32,69,103] ; to 18[33] to 24 months[22]. There was a wide range of reported hospitalisation rates according to population and disease studied, from 1.3% to almost 30%.

Overall Hospitalisation

One study reported hospitalisation for any reason and one reported hospitalisation for any illness. Hospitalisation rates were 17.5% in the 12 months[32] and 26% in the first 18 months[33] respectively. Results were inconsistent, for example one study found breastfed infants were less likely to be hospitalised (relative risk; 95%CI = 0.48; 0.24-0.94 for infants who were exclusively breastfed for any length of time compared with infants who were never breastfed)[32]. Whereas another study found that breastfed infants were more likely to be hospitalised (relative risk; 95%CI =1.24; 1.11 – 1.38)[33]. After adjusting for a number of potentially confounding variables including maternal

education, results from Ladomenou *et al*[32] were slightly attenuated to a significance of p=0.11, while results from Leung *et al*[33] remained similar.

Infection

Two studies reported hospitalisation for any type of non-perinatal infection. The percentage of participants hospitalised was 14.5%[32] and 5.6 %[69], with respective corresponding univariable relative risk (95% CIs) for risk of hospitalisation if ever BF versus never BF of 0.39 (0.15, 1.05) and 0.51 (0.18, 0.95). In the study of Ladomenou[32], the effect was attenuated from p=0.03 to p=0.16 after adjusting for potential confounders, however Paricio-Talayero[69] found breast-feeding remained significant at the p<0.01 level.

Respiratory Tract Infection

Four studies reported hospitalisation for respiratory tract infection. The percentage of participants hospitalised for various respiratory tract infections were as follows: 1.0% lower respiratory infection[19], 6.2% upper respiratory tract infection and lower respiratory infection combined[103], 0.2% asthma[22], and 18% for combined respiratory and febrile illness[33]. Univariable relative risk (95%CIs) of hospitalisation for ever-BF versus never-BF was 0.60 (0.51, 0.72) in the Davidson *et al* study[22] and 0.53 (0.36,0.80) the Taylor *et a*[19] study. In the Oddy *et al*[103] study the univariable relative risk (95%CIs) for predominant BF < two months versus predominant BF > two months were 0.43 (0.23, 0.82) for upper respiratory tract infection and 0.54 (0.35, 0.83) lower respiratory infection. Leung *et al*[33] did not report univariable results.

Davidson *et al*[22] constructed a multivariable model to predict hospital admission, and included variables if they were significant at the alpha=0.05 level. Mode of feeding was not included in the final model. Similarly, in Taylor *et al* the mode of feeding was not statistically significant in multivariable analyses for either upper respiratory tract infection, or for lower respiratory infection and upper respiratory tract infection combined[19]. Leung *et al*[33] reported that rates of hospitalisation did not differ significantly based on mode of feeding using multivariable analysis.

Gastrointestinal Illness

Two studies reported hospitalisation for gastrointestinal illness. The percentage of participants hospitalised for gastrointestinal illness was 1.5% from Taylor *et al*[19] and 7% from Leung *et al*[33].

Taylor *et al*[19] found a decreasing relative risk of hospitalisation if ever BF versus never BF, 0.54 (0.38, 0.76). However, when Taylor *et al*[19] constructed a multivariable model, mode of feeding was not significant. Leung *et al*[33] reported results of multivariable analyses, and found the rates of hospitalisation did not differ significantly based on mode of feeding.

Jaundice

One study investigated hospitalisation for jaundice[33] with four percent of children being hospitalised in the first 18 months of life. Infants who were exclusively breastfed for any length of time were more likely to have been hospitalised than those never breastfed (relative risk = 3.27; 95%CI: 2.45 – 4.36). All hospitalisations occurred in the first nine months of life. This relationship remained after adjustment for a number of potentially confounding variables.

Relationship according to duration of breast-feeding

There were five studies that recorded duration of breast-feeding. While Ladomenou *et al*[32] recorded BF as exclusive or partial, no recording of other liquids or food was made. Ladomenou *et al*[32] found that infants exclusively BF for longer were less likely to be hospitalised for infection (p=0.037). Length of partial BF was unrelated to hospitalisation for infection. Leung *et al*[33] however, compared never BF with mixed feeding, exclusively BF<1 month, exclusively BF two to three months and exclusively BF > four months and did not find evidence of decreasing hospitalisation with increasing duration for any of the four outcomes studied. In all cases effect estimates were similar across feeding categories, with overlapping confidence intervals. Oddy *et al*[103] did not find evidence of a dose-response relationship for upper respiratory infection, but the authors suggested that protection against admission to hospital for lower respiratory tract infection may increase in infants if they are predominantly BF past six months of age. Paricio-Talayero *et al*[69] conducted a multivariable analyses and reported that, compared to infants who were exclusively BF for > four months, risk for admission for infection in the first year of life was 4.9 (95%CI 2.4,10.0) times higher among infants who never received full BF and 2.5 (95%CI 1.3,4.7) times higher among those who received full BF for < four months. Similarly, Taylor *et al*[19] reported that the increased duration of BF was significantly associated within the first year to reduced risk of admission for lower respiratory admissions univariably, but not multivariably, and that admission for gastroenteritis was not associated with exposure to BF.

Quality of included studies

Bauchner and colleagues[29] used four methodological standards that relate to both the internal and external validity and the generalisability of studies of the association between breastfeeding and infection. These standards were: avoidance of detection bias, a clear definition of breastfeeding, a clear definition of infection, and adjustment for confounding variables, which were transferrable to those required for this review. The six included studies for this review were a mixture of prospective and retrospective observational cohort studies. Detection bias is likely to be present as hospitals in different countries are likely to have different thresholds for admission. This may partially explain the heterogeneity in admission rates between studies. Breastfeeding definition was inconsistent across the studies, with different measures of exclusivity and duration applied. Study outcomes were recorded by either maternal report or hospital records, and are likely to be accurate as previous studies have shown maternal report to be a valid measure of hospitalisations. Studies collected a range of potentially confounding variables, including either maternal education or a measure of social class, which were accounted for in the analysis. It is notable that the smaller studies reported the strongest associations between mode of feeding and hospitalisation, consistent with the possibility of publication bias. Although significant associations were also present in the larger studies, they were strongly attenuated after adjustment for potentially confounding variables.

Discussion

This is the first review to combine the results of individual examinations to determine the association between breastfeeding and hospitalisation in infancy. We identified that individual studies reported varying results, and the quality of all studies was less than desired due to inconsistent definitions of both breastfeeding and hospitalisation outcome. Studies consistently reported a univariable association between breastfeeding and reduction of infant hospitalisation; however the association between duration of feeding and hospitalisations was more ambiguous. When a limited number of potentially confounding variables were included in multivariable analyses, many of the adjusted effects of breastfeeding became statistically non-significant. Significant confounding factors which increased the risk of hospitalisation with univariable and multivariable modelling within the studies were found to be: having siblings[22,32,69,103], maternal age[32,33,103], low birth weight[22,33,69 19], male gender[22,103], disadvantage (low socioeconomic status)[19,22], maternal smoking[19,22], season[32], parental education[32], multiple birth[32], ethnicity[32], maternal asthma[22] and delivery type[22]. The information contained in the studies would have been more interpretable if overall breastfeeding rates at the time of hospitalisation were presented, but

they were not reported in any of the six studies, with percentages or odds ratios used to represent this data.

This research highlights the paucity of quality studies comparing feeding method and hospitalisation in infants. The measurement of infant feeding is inconsistent across the included studies and lacks any detail, except for breastfeeding that was also inconsistently measured in definition and duration. Lademenou *et al*[32] noted that more attention has been paid to the effects on the frequency rather than the severity of infectious episodes. Infant hospitalisation data did not include length of stay, diagnostic or severity of illness measures, although hospitalisation can be classified as a measure of severity.

The interpretation of duration of breastfeeding and hospitalisation is affected by the consistency and method of measuring breastfeeding; within the six studies various measurements of breastfeeding were made. The studies selected spanned a 30-year time frame and, in the areas of respiratory infection and gastrointestinal disease, remained consistent. This is especially important when considering the increasing rate of mothers initiating breastfeeding during that time. There was limited consistency between studies in data presentation. In particular, there was no consensus between the studies concerning the description of breastfeeding despite most studies citing World Health Organization recommendation definitions[12] they did not adhere to these recommendations when defining breastfeeding themselves. There was no discussion or reporting of what alternative feeding was being offered or in what amount, and the introduction of complementary feeding was not reported. The description of specific illness such as gastrointestinal illness limits studies to what is known, that is breastfeeding is known to reduce gastrointestinal illness. The studies that were reviewed and analysed found a positive effect of breastfeeding on all illnesses except jaundice. While consistent, effects were not strong, and the effect of confounding factors was not fully explored.

Previous reviews have focused on breastfeeding and specific disease relationships and not hospitalisation for any illness. Bauchner *et al*[29] investigated the relationship between infant feeding and infections and applied the four key methodological criteria described previously to evaluate the scientific quality and reliability to 20 studies. This included 14 cohort studies, of which eight found a protective effect of breastfeeding against infant infection and six found no evidence of protection. Four of the six case-control studies examined found evidence of a protective effect. The most significant finding of the Bauchner *et al*[29] review was the identification of significant methodological flaws in all but two of the studies. Our review has found similarly that studies

continue to be flawed especially in reporting of breastfeeding. Although a study by Bachrach *et al*[21] reported a threefold protective effect of breastfeeding in the risk of hospitalisation for respiratory disease, our results do not support this finding. The Bachrach[21] study purposefully chose studies that characterised breastfeeding as exclusive. An inclusion criteria was a minimum exposure of two months of exclusive breastfeeding or nine months of any compared with its absence, with an assumption that women who breastfeed 'long-term' also breastfeed exclusively in the first months. The Bachrach study also used a hypothetical population of studies of breastfeeding with subgroup analysis used to obtain the final results.

Strengths of this study are its methodological robustness. We conducted a comprehensive search on multiple databases, and used a clear definition of infant feeding as ever having breastfed. The included studies have reported the effects of breastfeeding in preventing hospitalisation despite minimal duration measures. To aid in consistency of context we only included studies from developed countries. The studies included in this review did not consistently measure potentially confounding variables and the measurement of illness; such as the duration and intensity of the illness, including hospital length of stay.

Although breastfeeding has many beneficial effects on infant and maternal health, it is not clear whether it is causally associated with reduced infant hospitalisations. While there is a clear univariable association with reduced infant hospitalisations, the effect is reduced after statistical adjustment for possible confounders. While the 'gold standard' studies for establishing causality, randomised controlled trails, are impractical in this context, there is no doubt that more high-quality prospective observational studies are required to extricate the effect of breastfeeding compared with other factors such as maternal smoking or education, as these factors are also associated with infant hospitalisation rate. Future studies must consistently measure mode of feeding, as the inconsistent recording of intensity and duration of breastfeeding in the studies included in this review may be the reason protective effects of breastfeeding in reducing hospitalisation are not clear. Without the ability to use a randomised controlled trial, adjustment for potentially confounding variables must take place during the analysis phase of the study, so future studies must accurately record all variables that affect the potential reason for hospitalisation. Further research could focus on the duration of breastfeeding, timing of introduction of solid food, other milks, medication, and illness factors such as chronicity, in relation to hospitalised infants.

Conclusions from the manuscript

- A systematic review explored whether mode of feeding is associated with risk of hospitalisation for illness during infancy in developed countries.
- We found a clear univariable association of breastfeeding with reduced infant hospitalisation and affect was reduced after statistical adjustment for possible confounders.
- Although breastfeeding has many beneficial effects on infant and maternal health, it is not clear whether it is causally associated with reduced infant hospitalisations.

Table 4.1 Studies that provided data for inclusion in the systematic review

Study	Design	Source of data	Year-born, age outcome measured(months)	Number Breast-fed, Number formula-fed	Feeding measures	Source of information on feeding	Outcome measure	Source of outcome information	Potential confounders considered in analysis	Children hospitalised by mode of feeding: reason, breast fed, formula fed
Davidson et al; BMC Pulmonary Medicine 2010,10:14	Prospective cohort	Oxford record linkage study (England)	1970 - 1989, 24 months	173133, 74944	Ever/Never Breastfed	Medical records at post natal discharge	Hospitalisation asthma	Hospital records	Social class, maternal asthma. Marital status, maternal smoking in pregnancy, birth order, gender, birthweight, gestational age, delivery type, parity	Asthma,0.2%; 0.4%
Ladomenou et al; Arch Dis Child 2010 95:1004-1008	Prospective cohort	A representative sample of infants, recruited in maternity ward (Greece)	2004-2005, 12 months	926,562	None/Partial/Exclusive breastfeeding	Maternal interview postnatal, 1,3,6 and 12 months	Any reason, Any infection	Maternal report	Siblings, ethnicity, parental education level, birthweight, gender, delivery type, season of birth (autumn/spring),	Any reason, 5.4%, 13.8% Any infection, 4.4%, 11.1%
Leung et al;Epidemiology 2005;16 (3)May 328-335	Prospective cohort	A population of infants brought to a Maternal and Child Health Centre for their first visit within 2 weeks of birth (Hong Kong)	1997, 18 months	8327, 3248	Initiation/ Duration/Exclusivity	Maternal questionnaire postnatal, 3,9 and 18 months	Any illness Jaundice,Gastrointestinal illness, Respiratory tract Infection, Other illness	Maternal report	Infant feeding history, delivery type, birth weight,maternal age,education and fulltime employment, birth order,gender,gestational age, environmental tobacco smoke exposure	Any illness, 28.1%, 24.3% Jaundice, 5.9%, 2.3%
Oddy et al.,Arch Dis Child 2003 88:224-228	Prospective cohort	The Western Australian Pregnancy Cohort Study (Australia)	1989-1992, 12 months	2456, 2196	Initiation/Duration	Maternal questionnaire at 12 months	Upper respiratory tract infection, Lower respiratory tract infection	Maternal report	Gender, gestational age ,smoking in pregnanacy, older siblings, maternal age and education,	Upper RTI, 1.1%, 2.6% Lower RTI, 2.8%, 5.1%
Paricio-Talyero et al.,Pediatrics 2006;118;e92-e99	Prospective cohort	Nutritional Well Child Program (Spain)	1996-1999, 12 months	1385, 1163	Initiation/Duration	Maternal report at 6 months	Infection	Maternal report/medical record	Gender, birthweight, parity, prematurity, twin status, birth month, maternal age, education and employment, smoking, economic level and location.	Infection, 4.6%, 14.4%
Taylor et al.,Lancet, May29,1982	Prospective cohort	British Birth Survey (Child health and education study) (England)	1970, 12 months	13125, 4226	Initiation/Duration	Maternal report at birth and 5 years	Lower respiratory illness, gastrointestinal illness	Maternal report	Gender, birth weight, birth rank, maternal smoking, social index	Lower RTI, 0.7%, 1.3% Gastrointestinal illness,1.0%, 1.8%

CHAPTER 5: THE IMPORTANCE OF AUDIT

5.1 Introduction

The infant's feeding history is essential information required before an accurate assessment of how the infant has been fed from birth and their concurrent health can be made, and is pertinent to forming an accurate diagnosis. Infant feeding can be the reason for presentation and/or admission to hospital. The aim of this study is to identify the frequency, and the extent of documentation of infant feeding including how the infant has fed since birth in charts of infants presenting and /or admitted to a paediatric hospital.

5.2 Manuscript details

The manuscript details are as follows:

Williams LA, Ware RS, Davies PSW. Hospital, infants and feeding: the importance of audit. Journal of Paediatrics and Child Health. 2015 doi:10.1111/jpc.12824

The manuscript has been reformatted to fit the requirements of the thesis.

5.3 Hospital, infants and feeding: the importance of audit

Lesley Alison Williams, Robert S Ware, Peter SW Davies

Abstract

Aim: Infant feeding can be the reason for presentation and/or admission to hospital. The aim of this study was to identify if infant feeding history was documented in charts of infants presenting and/or admitted to a paediatric hospital.

Methods: A systematic random sample of hospital charts of infants who had presented to the emergency department between 1st July 2011 and 30th June 2012 were audited for presence of documentation of feeding.

Results: In total 465 charts were audited, representing 12.5% of infants who presented to the emergency department in the year. Frequency of documentation for feeding measures was: feeding mode 263(57%), feeding type 228 (49%), feeding frequency 119 (26%) and with changes 89 (19%) since birth. Increasing infant age was significantly associated with less frequent recording of feeding mode, type, frequency and changes.

Conclusion: A comprehensive feeding history is not recorded on many occasions of infant presentation and/or admission to hospital. The identification of feeding mode, type, frequency and changes is needed in order to explore the existence, or otherwise, of a relationship between feeding and the reason for presentation and/or admission.

Keywords: audit, developed country, feeding, hospital, infant

Introduction

The infant's feeding history is essential information required before an accurate assessment of how the infant has been fed from birth and their concurrent health can be made, and is pertinent to forming an accurate diagnosis. Infant feeding can be the reason for presentation and/or admission to hospital. There is a paucity of studies, which have assessed the recording of feeding history for infants who present or are admitted to paediatric hospitals[104]. Research into the risks and benefits of the type of infant feeding have primarily focused on the decreased likelihood of illness for breastfed, compared to formula fed, infants, rather than on whether or not the infant was hospitalised[19,22,32,33,69,103]. The primary outcome of this study is to identify if feeding is documented, and the secondary aim is to explore associations between feeding documentation and socio-demographic factors.

Oddie et al[105] in a UK study of early discharge and readmission to hospital in the first month of life of 907 infants and identified that medical notes were generally of poor quality, feeding problems under ascertained on admission and not always commented on in the medical record. Tyler and Hellings[106] conducted a study in the USA of feeding method and rehospitalisation in 143 infants during the first month of life and reported that comprehensive feeding histories were not well documented in many charts.

The aim of this study is to identify the frequency, and the extent of documentation of infant feeding including how the infant has fed since birth in charts of infants presenting and /or admitted to a paediatric hospital.

Methods

Study population

A retrospective chart audit at the Royal Children's Hospital (RCH) in Brisbane, Australia occurred during October–December 2012. The RCH is a tertiary paediatric hospital. In the 2011/2012 financial year there were 3800 infant (0-1 year) presentations to the emergency department and 2110 infant admissions. To obtain a representative proportion of charts for presentation and admission of infants to hospital, medical records were selected and audited from infants presenting or admitted via the emergency department between 1st July 2011 and 30th June 2012. To capture the seasonality of presentations, a sample of ten percent of each month's presentation of infants' charts

was audited. Records were identified for audit using computer generated random numbers. Records were not selected for audit by category of illness or injury, to capture a representative range of presentation. The Human Research Ethics Committees of the University of Queensland and the Queensland Children's Health Services provided ethical approval (Appendices 1 and 2).

Data collection

The data collection form (Appendix 6) was developed after consultation with medical staff and human information management services staff to best reflect the recording of feeding mode, type and frequency. The first version was piloted with five charts, minor revisions made before the audit commenced.

Data extracted were recording of feeding type (e.g. breast, expressed breast milk, formula, cow's milk, solid food) with changes since birth, the mode of feeding, (e.g. breast, bottle or tube feeding) and feeding frequency. The demographic and social data extracted were date of birth, actual gestational age, gender and postcode of residence. For each individual a socio-economic tertile was obtained by linking Socio-Economic Indexes for Areas (SEIFA) data to postcode of residence[97]. Age at presentation was categorized as 0-6, 7-12, 13-26, 27-39 and 40-52 weeks. Other data recorded included the date of this presentation, delivery type and whether diagnosis was recorded.

Statistical Analysis

Data were presented as frequency (percentage). The association between infant characteristics and presence of recording was investigated using logistic regression, first univariably, then multivariably. Multivariable models were adjusted for age, gender, gestational age, delivery type, SES tertile and diagnosis. Data were analysed using a software package for statistical analysis, IBM SPSS Statistics 22.

Results

Infant record characteristics

Four hundred and sixty nine infant records were identified for audit, of these two charts were incorrectly age identified and two infant records were unavailable. Just over half of the infants were male (56%) and 25% were aged 0-6 weeks. Gestation was recorded in 68% of charts and of these

255 (81%) were born at term. The type of infant delivery was recorded in 57% (264) of the charts of which 115 were born by caesarean section.

Feeding Mode

Feeding mode was recorded in 263 (**57**%) of infant charts. Analysis of recording of feeding mode identified that 97 (21%) of the infants where mode was recorded were being breastfed, 127 (27%) bottle fed and 39 (9%) as another mode of feeding which included for example, nasogastric or transpyloric feeding. Age of the infant was associated with the recording of feeding mode after adjusting for potentially confounding variables (Table 5.1). With increasing age of the infant at presentation there was less likelihood of the feeding mode being recorded, with infants aged 40-52 weeks significantly less likely to have the feeding mode recorded (OR=0.11; 95%CI 0.04-0.27). Preterm infants were less likely to have feeding mode recorded (OR=0.36 95% CI 0.14-0.88). There was no significant relationship between gender, delivery type, diagnosis and socioeconomic status.

Table 5.1 Univariate and multivariate analyses relating to feeding mode

		Number	**Feeding mode recorded**	**Univariable OR (95%CI)**	***p* value**	**Multivariable OR (95%CI)**	***p* value**
Age (weeks)	0-6	115	93 (80.9)	Reference		Reference	
	7-12	39	31 (79.5)	0.91 (0.37-2.26)	0.85	0.59 (0.19-1.78)	0.35
	13-26	91	46 (50.5)	0.24 (0.13-0.45)	<0.001	0.25 (0.10-0.60)	0.002
	27-39	110	61 (55.5)	0.29 (0.16-0.53)	<0.001	0.52 (0.19-1.40)	0.20
	40-52	110	32 (29.1)	0.09 (0.05-0.18)	<0.001	0.11 (0.04-0.27)	<0.001
Gender	Female	205	112 (54.6)	Reference		Reference	
	Male	260	151 (58.1)	1.15 (0.79-1.66)	0.45	1.29 (0.70-2.37)	0.40
Gestation	Term	279	189 (67.7)	Reference		Reference	
	Preterm	36	16 (44.4)	0.38 (0.18-0.77)	0.007	0.36 (0.14-0.88)	0.02
Delivery type	Vaginal	149	107 (71.8)	Reference		Reference	
	Caesarean	115	71 (61.7)	0.63 (0.37-1.06)	0.08	0.75 (0.41-1.39)	0.37
Diagnosis	Yes	409	237 (57.9)	Reference		Reference	
	No	56	26 (46.4)	0.62 (0.35-1.10)	0.10	0.69 (0.24-1.98)	0.50
SES	High	357	194 (54.3)	Reference		Reference	
	Middle	86	56 (65.1)	1.56 (0.96-2.56)	0.07	0.63 (0.12-3.33)	0.59
	Low	22	13 (59.1)	1.21 (0.49-3.37)	0.66	0.70 (0.11-4.16)	0.69

Multivariable analysis adjusted for age, gender, gestational age, delivery type, SES and diagnosis.

Feeding type

Feeding type was recorded in 228 (49%) of charts, Analysis of recording of feeding type identified that 113 (24%) of the infants were recorded as receiving breast milk(including expressed breast milk) and 93 (20%) as receiving another form of milk. Of feeding type recorded, 17 (3%) included solid food and 18 (4%) included cow's milk. Age of the infant was significantly associated with recording of feeding type in multivariable analysis (Table 5.2). Infants aged over 12 weeks were less likely to have feeding type recorded and those aged 40 to 52 weeks were the least likely to have the feeding type recorded (OR=0.06; 95% CI: 0.02-0.15). Other significant associations with feeding type in multivariable analysis were gestation with pre-term infants (OR=0.31; 0.12-0.78) and female infants (OR=1.91; 95% CI; 1.05-3.50) less likely to have feeding type recorded. There was no significant relationship between delivery type, diagnosis and socioeconomic status.

Table 5.2 Univariate and multivariate analyses relating to feeding type

		Number	**Feeding type recorded**	**Univariable OR (95%CI)**	***p* value**	**Multivariable OR (95%CI)**	***p* value**
Age (weeks)	0-6	115	89 (77.4)	Reference		Reference	
	7-12	39	26 (66.7)	0.58(0.26-1.29)	0.18	0.49 (0.17-1.40)	0.18
	13-26	91	42 (46.2)	0.25(0.13-0.45)	<0.001	0.24 (0.10-0.57)	0.001
	27-39	110	41 (37.3)	0.17(0.09-0.31)	<0.001	0.25 (0.10-0.63	0.003
	40-52	110	30 (27.3)	0.11(0.06-0.20)	<0.001	0.06 (0.02-0.15)	<0.001
Gender	Female	205	93 (45.4)	Reference		Reference	
	Male	260	135 (51.9)	1.30(0.90-1.87)	0.16	1.91(1.05-3.50	0.03
Gestation	Term	279	165 (59.1)	Reference		Reference	
	Preterm	36	14(38.9)	0.44(0.21-0.89)	0.02	0.31 (0.12-0.78)	0.01
Delivery type	Vaginal	149	95 (63.8)	Reference		Reference	
	Caesarean	115	62 (53.9)	0.66(0.40-1.09)	0.10	0.85 (0.46-1.57)	0.61
Diagnosis	Yes	409	202 (49.4)	Reference		Reference	
	No	56	26 (46.4)	0.88(0.50-1.55)	0.67	0.90 (0.31-2.58)	0.84
SES	High	357	171 (47.9)	Reference		Reference	
	Middle	86	45 (52.3)	0.76(0.32-1.81)	0.54	0.61 (0.12-3.03)	0.55
	Low	22	12 (54.5)	0.91(0.35-2.34)	0.85	0.84(0.19-3.74)	0.82

Feeding frequency

Feeding frequency was recorded in 119 (26%) of charts. Feeding frequency pertains to how often the infant is fed. Age of the infant was significantly associated with the recording of feeding frequency in multivariable analysis, as the age of the infant increased there was less likelihood of the frequency of feeding being recorded e.g. infants aged 40-52 weeks were less likely to have feeding frequency recorded than infants aged 0-6 weeks (OR=0.20 95% CI 0.08-0.49) (Table 5.3). There was no significant relationship found between gender, gestation, diagnosis and socioeconomic status.

Table 5.3 Univariate and multivariate analyses relating to feeding frequency

		Number	**Feeding frequency recorded**	**Univariable OR (95%CI)**	***p* value**	**Multivariable OR (95%CI)**	***p* value**
Age (weeks)	0-6	115	56 (48.7)	Reference		Reference	
	7-12	39	11 (28.2)	0.41(0.18-0.91)	0.02	0.31 (0.12-0.82)	0.18
	13-26	91	22 (24.2)	0.33 (0.18-0.61)	<0.001	0.25 (0.11-0.57)	0.001
	27-39	110	18 (16.4)	0.20 (0.11-0.38)	<0.001	0.18 (0.07-0.48)	0.001
	40-52	110	12 (10.9)	0.12 (0.06-0.26)	<0.001	0.20 (0.08-0.49)	<0.001
Sex	Female	205	47 (22.9)	Reference		Reference	
	Male	260	72 (27.7)	1.28 (0.84-1.96)	0.24	1.27 (0.70-2.28)	0.42
Gestation	Term	279	85 (30.5)	Reference		Reference	
	Preterm	36	8 (22.2)	0.65(0.28-1.49)	0.31	0.99 (0.37-2.64)	0.99
Delivery type	Vaginal	149	57 (38.3)	Reference		Reference	
	Caesarean	115	29 (25.2)	0.54 (0.31-0.92)	0.02	0.55(0.30-1.00)	0.53
Diagnosis	Yes	409	107 (26.2)	Reference		Reference	
	No	56	12 (21.4)	0.77(0.39-1.51)	0.44	1.18 (0.43-3.22)	0.73
SES	High	357	83 (23.2)	Reference		Reference	
	Middle	86	29 (33.7)	0.64 (0.25-1.64)	0.36	0.64(0.17-2.45)	0.52
	Low	22	7 (31.8)	1.09 (0.40-2.97)	0.86	0.89 (0.21-3.78)	0.37

Feeding changes

Feeding changes was recorded in 89 (19%) of infant charts. The recording of feeding changes identifies if feeds have changed e.g. from breast to bottle or bottle to nasogastric tube feeds. With increasing age of the infant at presentation there was less likelihood of feeding changes being recorded (Table 5. 4). Infants aged 40-52 weeks were less likely to have feeding frequency recorded in univariable analysis (OR=0.26; CI 95% 0.13-0.55) but not multivariable analysis. On univariable analysis a significant relationship was found between feeding frequency and delivery type OR=0.54; CI 95% (0.31-0.92) but no significance on multivariable analysis.

Table 5.4 Univariate and multivariate analyses relating to feeding changes

		Number	**Feeding changes recorded**	**Univariable OR (95%CI)**	***p* value**	**Multivariable OR (95%CI)**	***p* value**
Age (weeks)	0-6	115	36 (31.3)	Reference		Reference	
	7-12	39	11 (28.2)	0.86 (0.38-1.92)	0.71	0.94 (0.36-2.42)	0.33
	13-26	91	15 (16.5)	0.43 (0.21-0.85)	0.01	0.39 (0.16-0.97)	0.10
	27-39	110	15 (13.6)	0.34 (0.17-0.67)	0.002	0.46(0.17-1.21)	0.87
	40-52	110	12 (10.9)	0.26 (0.13-0.55)	<0.001	0.36 (0.14-0.92)	0.67
Sex	Female	205	34 (16.6)	Reference		Reference	
	Male	260	55 (21.2)	1.34(0.84-2.16)	0.21	1.35(0.72-2.53)	0.30
Gestation	Term	279	63 (22.6)	Reference		Reference	
	Preterm	36	7 (19.4)	0.82 (0.34-1.97)	0.67	1.02 (0.37-2.80)	0.002
Delivery type	Vaginal	149	39(26.2)	Reference		Reference	
	Caesarean	115	26 (22.6)	0.82 (0.46-1.45)	0.50	0.84 (0.45-1.57)	0.59
Diagnosis	Yes	409	13 (23.2)	Reference		Reference	
	No	56	76 (18.6)	1.32(0.67-2.58)	0.41	0.58 (0.22-1.54)	0.28
SES	High	357	68 (19)	Reference		Reference	
	Middle	86	15 (17.4)	0.62 (0.23-1.66)	0.34	0.69 (0.30-1.59)	0.39
	Low	22	6 (27.3)	0.56 (0.18-1.67)	0.30	1.62 (0.43-6.08)	0.47

Discussion

Summary of main findings

Infant feeding type, frequency and changes was not recorded on many occasions. The factor most significantly associated with recording of feeding mode, type, frequency and changes was infant age, with recording decreasing as age increased. A comprehensive feeding history is an important omission as during a hospital presentation or admission, feeding is not being assessed in the context of the infant's health. The retrospective cross- sectional nature of this study allows the observation of associations, but not causal effects of the reason for presenting to a paediatric hospital.

In recent decades, studies have reported the type of breastfeeding exclusive, predominant or partial with all forms of other feeding grouped together[107]. There is no differentiation in the studies if the artificial feeding offered is for example, a formulation of soy or cow's milk. There is no clarification of how the formula is prepared or given. The studies rarely include data on when complementary feeding was introduced and the timing around when the infant became ill. Studies designed to assess the association between infection rates and the age of introduction of complementary food in both formula and breastfed infants are scarce[61]. Despite official guidance about infant feeding many mothers continue to introduce formula into an infant's diet in the early weeks following birth[48,49], The failure of targeted breastfeeding initiatives to succeed in increasing breastfeeding rates, as well as extending breastfeeding duration[108], has not been explored in relation to an infant's health. With the emphasis on 'breast is best' in ongoing health promotion campaigns and the professional indecisiveness of the recommendations for the timing of the introduction of complementary food[108 62,109-111] there appears to be confusion in how feeding should be assessed and reported.

This study's findings suggest that feeding is infrequently investigated as a potential underlying causal reason for presentation to the emergency department at a paediatric hospital. Poor recording of feeding history may be reflective of a lack of gravity, lack of knowledge and confusion as to how feeding is assessed and reported, especially in relation to illness and hospitalisation. Comprehensive feeding documentation should include three categories: first, the mode of feeding which describes how the feed is delivered to the infant (e.g. breast, bottle or enteral), with the recording of feeding changes from birth; second, the type of fluid used, for example, breastmilk, expressed breast milk or

infant formula designed for a specific group: neonates, zero to six months of age, hypoallergenic infant or cow's milk.

The documentation of the introduction of complementary feeding (solid food) should also be made; third, feeding frequency, that is, the documentation of how often the infant is fed. A comprehensive feeding history which identifies a relationship between infant feeding and emergency department presentation may reduce unnecessary diagnostic testing, reduce potential incorrect diagnoses and identify the latent reason for early discontinuation of breastfeeding.

In this study, a comprehensive feeding history is not recorded on many occasions of infant presentation and / or admission to hospital. The recording of feeding mode, type, frequency and changes is needed in order to explore the existence, or otherwise, of a relationship between feeding and the reason for presentation and/or admission.

CHAPTER 6: AN AUDIT OF MEASURE OF INFANT GROWTH AT PRESENTATION TO HOSPITAL

6.1 Introduction

Infants who present or are admitted to hospital with illness or with inadequate growth and development are those most at risk of decreased nutritional status. The aim of this study was to identify how frequently anthropometric measurements were documented in charts of infants presenting and or admitted to a tertiary paediatric hospital.

6.2 Manuscript details

Williams LA, Ware RS, Davies PSW. Back to basics: An audit of measurement of infant growth at presentation to hospital. Australian Health Review 2015 doi: 10.1071/AH14165

The manuscript has been reformatted to fit the requirements of the thesis.

6.3 Back to basics: An audit of measurement of infant growth at presentation to hospital.

Lesley Alison Williams, Robert S Ware, Peter SW Davies

Abstract

Objectives: Infants who present or are admitted to hospital with illness or with inadequate growth and development are those most at risk of decreased nutritional status. However, not all infants who present or are admitted to hospital have their growth assessed. The aim of the present study was to identify how frequently anthropometric measurements were documented in charts of infants presenting and/or admitted to a tertiary paediatric hospital.

Methods: A systematic random sample of hospital charts of infants who had presented to the emergency department between 1st July 2011 and 30th June 2012 was audited retrospectively for presence of appropriate documentation of measurement.

Results: In all, 465 charts were audited, representing 10% of infants who presented to the emergency department in the year. Frequency of anthropometric measures was: birth weight 103 (22%), presentation weight 275 (59%), length 8 (2%), head circumference 15 (3%), percentiles 27 (6%) and body mass index score 1 (0%). Age of the infant was significantly associated with recording of birth weight. There were no significant relationships found between gender, socioeconomic status, gestational age, delivery type and recording of diagnosis and birth weight.

Conclusions: Infant measurements were not recorded on many occasions. Assessment of growth as a marker of illness or nutritional deficit has been poorly assessed in this group. This is a missed opportunity to assess infant growth in this population which has been found to be at risk of decreased nutritional status. Identification and treatment of growth deficits are a cost effective method of optimising infant health worldwide.

Introduction

Growth is the best indicator of nutritional status[35] and all infants should be weighed and measured when they present or are admitted to hospital. A high proportion of hospitalised paediatric patients in developed countries are malnourished[37,101,112-115]. Infants presenting or admitted to hospital in developed countries with illness or, possibly undiagnosed, inadequate growth and development are at risk of a sub-optimal nutritional status[37,114,116]. Emond[117] found a positive association between poor growth from birth to eight weeks and feeding problems, illness or hospitalisation in southwest England. The feeding problems associated with inadequate weight gain were difficulty in feeding and weak sucking, the latter reported as equally important in breast and bottle fed infants[117]. Sissaoui and colleagues[115] estimated the frequency of malnutrition in a recent large scale study in paediatric hospitals across France. A one-day survey of 923 children, admitted on that day were weighed and measured. The five children considered to be malnourished by World Health Organization standards (but not French standards) were all aged less than one year. While identifying levels of malnutrition, recent studies in this area have failed to report the routine recording of measurement or its absence[101,112,113,118].

Of fundamental importance to establishing a strategy for maintaining and/or recovering nutritional status during hospitalisation is an understanding of the nutritional status of hospitalised children, including infants[101]. Plotting of growth curves on appropriate charts remains the simplest way to assess nutritional status in children[116]. However, the diversity of medical conditions and syndromes in hospitalized children, including infants, require a tailored approach to interpretation[36]. Infants have individual feeding histories and patterns of illness and injury.

Two studies have examined weight, length and head circumference recording in hospitalized infants in developed countries[119,120]. Lek and Hughes[119] selected 18 non-emergency clinical episodes involving children aged under two years and found 6 (33%) were measured for weight, 1 (5.6%) was measured for length (5.6%) and 2 (11.1%) had head circumference measured. The study of Grek and Puntis[120] study in a paediatric hospital in the UK of 50 children, with a median age of 13 months found that weight was measured on 49(98%) occasions, however only 3(6%) had length or height measured.

The aim of the present study was to identify if the measurements of weight, length and head circumference were documented in charts of infants presenting and/or admitted to a paediatric hospital.

Methods

Study population

A retrospective chart audit at the Royal Children's Hospital (RCH) in Brisbane, Australia occurred during October –December 2012. The RCH is a tertiary paediatric hospital with approximately 25000 (0-15 years) presentations annually to the emergency department. Infant presentations contributed approximately one sixth of this number (4688) in the 2011-12 financial year. Medical records, selected from infants who had presented to the emergency department between 1 July 2011 and 30 June 2012 were audited. To obtain a representative proportion of charts to reflect seasonality presentations, a sample of ten percent of each month's presentation of infants' charts was audited. Records were identified for audit using computer generated random numbers. Records were not selected for audit by category of illness or injury, or whether they had been admitted to capture a representative range of presentation. The Human Research Ethics Committees of the University of Queensland and the Queensland Children's Health services provided ethical approval (Appendices 1 and 2).

Data collection

The data collection form (Appendix 6) was developed after consultation with medical staff and human information management services staff to best reflect the recording of measurements and feeding within charts. The first version was piloted with five charts, minor revisions were made before the audit commenced. Data extracted were date of birth and gender and a socioeconomic (SES) tertile was obtained for each individual by linking Socio-Economic Indexes for Areas (SEIFA) data at the postcode level (13). Other data were recording of diagnosis, gestational age, delivery type, birth weight, length, and head circumference, date of presentation and the anthropometric measures; weight, bare weight, birth length and head circumference. Additional assessment pertinent to nutritional status such as weight- for- age Z score was recorded if documented.

Statistical Analysis

Data were presented as frequency with percentages in parentheses. The association between infant characteristics and presence of recording was investigated using logistic regression, first univariate

analysis and then with multivariate models adjusted for age, gender, gestational age, delivery type, SES tertile and diagnosis. Data were analysed using a software package for statistical analysis, IBM SPSS Statistics 22.

Results

Infant record characteristics

Four hundred and sixty nine infant records were identified for audit, of these, two charts were incorrectly age identified and two infant records were unavailable. Of the records identified for audit, one quarter of the infants who had presented were admitted (24.6%). Just over half of the infants were male (56%) and 25% were aged 0-6 weeks. Gestation was recorded in 68% charts and, of these, 255(81%) were born at term. The type of infant delivery was recorded in 264 (57%) of the charts of which 115 (44%) were born by caesarean section.

Birth weight

Birth weight was recorded in 103 (22%) charts. Age of the infant was significantly associated with the recording of birth weight in both univariate and multivariate analysis. With increasing age of the infant at presentation there was less likelihood of the birth weight being recorded. Infants aged 40 to 52 weeks were less likely to have birth weight recorded in both univariate (odds ratio (OR) =0.06; 95%CI 0.03-0.15) and multivariate analysis (OR=0.10; 95%CI 0.04-0.27). There was no significant relationship found between gender, SES, gestational age, delivery type and recording of diagnosis or birth weight (Table 6.1).

Presentation weight

Presentation weight was recorded in 275 (59%) of charts, whereas weight was recorded as a bare weight in less than three percent of infant records. Univariate and multivariate analysis found no significant relationships between presentation weight and gender, gestational age, delivery type and diagnosis. Multivariate analysis found a significant relationship between age at 40-52 weeks and presentation weight, with less likelihood of recording of presentation weight in this age group (OR 2.27 95%CI 1.01-5.06).

Length, head circumference and percentile recording

Length and head circumference was recorded in 8 (2%) and 15 (3%) of charts, respectively. Percentile charts were present in 27 (6%) records, although this did not imply completeness of recording of weight, length and head circumference within each chart. Due to the small numbers of recording these data, regression analysis was not completed. Z scores for body mass index were noted in only one chart at presentation on audit.

Table 6.1 Univariate and multivariate analysis relating to growth data in hospital charts and key sociodemographic data.

Table 6.1 Univariate and multivariate analyses relating to growth data in hospital charts and key sociodemographic data.

		Number	Birthweight recorded n (%)	Univariable OR (95%CI)	*p* value	Multivariable OR (95% CI)	*p* value	Presentation weight recorded n (%)	Univariable OR (95% CI)	*p* value	Multivariable OR (95% CI)	*p* value
Age (weeks)	0-6	115	62 (53.9)	Reference		Reference		64 (55.7)	Reference		Reference	
	7 to 12	39	10 (25.6)	0.29 (0.13-0.66)	< 0.001	0.25 (0.10-0.65)	< 0.005	23 (59.0)	1.14 (0.54-2.39)	0.71	1.57(0.63-3.91)	0.32
	13-26	91	15 (16.5)	0.16 (0.08-0.32)	0.003	0.21 (0.09-0.47)	< 0.001	45 (49.5)	0.78 (0.44-1.35)	0.37	1.18 (0.56-2.48)	0.65
	27-39	110	8 (7.3)	0.06 (0.03-0.15)	< 0.001	0.16 (0.06-0.40)	< 0.001	71 (64.5)	1.45 (0.84-2.48)	0.17	2.18 (0.93-5.15)	0.07
	40-52	110	8 (7.3)	0.06 (0.03-0.15)	< 0.001	0.10 (0.04-0.27)	< 0.001	72 (65.5)	1.51 (0.88-2.58)	0.13	2.27 (1.01-5.06)	0.04
Gender	Female	205	43 (21.0)	Reference		Reference		124 (60.5)	Reference		Reference	
	Male	260	60 (23.1)	1.13(0.72-1.76)	0.58	1.10 (0.61-1.99)	0.74	151 (58.1)	0.90 (0.62-1.31)	0.60	0.57 (0.33-1.01)	0.05
Gestational age (weeks)	Term	279	88 (31.5)	Reference		Reference		148 (58.0)	Reference		Reference	
	Pre-term	36	9 (25.0)	0.70 (0.37-1.33)	0.28	0.84 (0.38-1.87)	0.67	41 (68.3)	1.56 (0.85-2.83)	0.14	1.65 (0.77-3.55)	0.19
Delivery type	Vaginal delivery	149	56 (37.6)	Reference		Reference		91 (61.1)	Reference		Reference	
	Caesarean section	115	38(33.0)	0.82 (0.49-1.36)	0.44	1.04 (0.57-1.91)	0.88	75 (65.2)	1.19 (0.72- 1.98)	0.49	1.13(0.64-1.98)	0.66
Diagnosis	Yes	409	87 (21.3)	Reference		Reference		35 (62.5%)	Reference		Reference	
	No	56	16 (28.6)	1.48 (0.79-2.76)	0.21	0.41 (0.15-1.11)	0.08	240 (58.7)	0.85 (0.47-1.51)	0.58	0.98 (0.37-2.56)	0.97
Socio economic status	High	357	74 (20.7)	Reference		Reference		212 (59.4)	Reference		Reference	
	Middle	86	23 (26.7)	1.43 (0.54-3.79)	0.46	1.33 (0.35-5.05)	0.67	54 (62.8)	0.47 (0.19-1.13)	0.09	0.33(0.09-1.24)	0.1
	Low	22	6 (27.3)	1.39 (0.81-2.40)	0..22	1.53 (0.72-3.24)	0.26	9(40.9)	1.15 (0.71-1..87)	0.56	1.03 (0.50-2.10)	0.93

Discussion

Summary of main findings

Infant measurements were not recorded on many occasions. Consequently, opportunities to assess growth and identify whether growth is suboptimal are being missed during a hospital presentation or admission. This audit is the first to focus on routine recording of basic measurements of growth in infants presenting to hospital who may then have been admitted, which may be indicative of findings in other hospital settings. The factor most significantly associated with recording of birth weight was infant age, with recording decreasing as age increased. This suggests that medical staff responsible for obtaining the infant history, place little significance of the presenting illness to perinatal outcomes that could be identified by factors including birth weight and ascertaining patterns of growth in the infant. Poor recording of gestational age and delivery type, the generalised failure to measure and record length and head circumference in infants, and incomplete percentile charts add weight to this assumption. Supporting this notion is a publication of Huysentruyt et al[114] who recently reported the lack of interest by healthcare workers in under nutrition as a major problem, following their study of hospital related under nutrition in hospitalized children in Belgium. This represents a missed opportunity to identify and treat poor nutritional status or growth in this population. The Committee on Nutrition of the European Society for Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) has recommended that nutrition support teams be established in paediatric hospitals and include screening for nutritional risk in paediatric hospitals and audit practice as part of their role[38].

Presentation weight was more likely to be recorded than birth weight. At presentation or admission an accurate weight is required for correct dosing of medication for infants and children and this could be a prime reason why presentation weight is recorded. There was a generalised failure to measure and record length and head circumference and complete percentile charts in this audit of infant charts. Presentation weight when not qualified by recording of it as being a bare weight may not be accurate. It cannot be assumed that infants are bare weighed (without clothing and nappy) unless this is recorded and in a paediatric setting it is important to document this information.

The outcomes of this audit support the findings of Lek and Hughes[119] in the audit of hospitalised children. The recent studies of malnutrition and hospitalisation have used measurement to identify children with decreased nutritional status and, although not auditing hospital practice, have

identified the increasing presence of underweight children (including some infants) in hospital[112,113,115,118,121].

The importance of recording anthropometry and gestation in assessing infant growth during infant presentation and/ or admission to hospital cannot be underestimated. In previous studies there has been minimal focus on infants, other factors need to be assessed in determining a decreased nutritional status compared to older children. For example, studies assessing nutritional status in hospitalised children purposefully excluded infants under 1 month of age[114,115,121], under 6 weeks of age[122], under 1 year of age[42] and under 2 years of age if they were inpatients or in the emergency department[119]. Exclusions are probably due to the difficulty in assessing and labelling nutritional status in infants less than one month of age.

Although debate continues about the ideal and most efficient assessment to identify malnutrition in the paediatric hospital setting, measuring weight, length and head circumference of infants and recording on appropriate growth charts on presentation or admission to hospital should always occur. While acknowledging that allocated triage category may indicate the severity of the infant's presenting problem, not measuring may preclude the identification of a minor manifestation of a more important nutritional or growth issue in infancy. In Australia, community child health surveillance is inconsistent and not all infants are monitored for growth in the community setting. All health professionals in developed countries should have the knowledge, skills and equipment to capably perform these procedures. Identification and treatment of malnutrition and growth deficits are a cost effective method of optimizing infant health. Despite increasing knowledge, little change has occurred in the identification and treatment of nutritional status in infants in the hospital setting.

CHAPTER 7: CHARACTERISTICS OF INFANTS WHO PRESENT TO A PAEDIATRIC HOSPITAL

7.1 Introduction

Optimal infant feeding via breast milk is thought to reduce the incidence of disease by contributing to both the passive protection and the development of the immune system of the infant[2,3 100] and improve long term health outcomes[123 11]. Given that sick and vulnerable infants potentially have the most to gain from receiving optimal feeding there is a paucity of literature focusing on infant feeding in infants presenting or admitted to hospital[5].

The aim of this study is to identify whether feeding mode is associated with clinical, demographic and social characteristics of the infant at presentation and/or admission of infants to hospital.

7.2 Manuscript details

Williams LA, Ware RS, Davies PSW. Characteristics of infants who present to a paediatric hospital: feeding history. Submitted for publication.

7.3 Characteristics of infants who present to a paediatric hospital: feeding history.

Lesley A Williams, Robert S Ware, Peter SW Davies

Abstract

Objective: Sick infants have the most to gain from optimal feeding yet there is a paucity of studies specifically on feeding in infants presenting or admitted to hospital. Choice of infant feeding may increase the risk of illness. This study investigated the association between clinical, demographic and social characteristics and infant feeding at presentation and/or admission to hospital.

Methods: A questionnaire based survey of parents to ascertain information about feeding, health and sociodemographic characteristics of infants who presented or were admitted to a tertiary paediatric hospital in Brisbane, Australia, during their first year of life. Data was collected between March 2013 and October 2013.

Results: Parents of 335 infants were surveyed, 23% of infants were aged 0-6 weeks of age (23%), 81% were born at term and 83% of mothers initiated breastfeeding. Infants who were preterm, delivered by caesarean section, or whose disease was first noticed at birth were less likely to have initiated breastfeeding. Breastfeeding at the time of presentation and/or admission was significantly associated with diseases of the skin and subcutaneous tissue and diseases of the musculoskeletal system and connective tissue, with not being higher SES, and with having longer disease duration.

Conclusions: Choice of infant feeding and characteristics may influence infant presentation and/ or admission to hospital, with a protective effect of breastfeeding reducing infection in some diagnostic categories.

Introduction

The association between infant feeding and infant health in developed countries has been the focus of much research[20 11] yet few studies have examined the association between infant feeding and morbidity requiring presentation and/or admission to hospital in infants born at term. Infant feeding, which could be breastfeeding, formula or solid food, is often overlooked amongst the primary reasons for presenting and/or admission to hospital. Optimal infant feeding via breast milk is thought to reduce the incidence of disease by contributing to both the passive protection and the development of the immune system of the infant[2,3 100] and improve long term health outcomes[123 11]. Given that sick and vulnerable infants potentially have the most to gain from receiving optimal feeding there is a paucity of literature focusing on infant feeding in infants presenting or admitted to hospital[5].

Previous studies in this area have primarily focused on assessing the risks and benefits of the type of infant feeding in relationship to illness, primarily that of breastfeeding versus formula feeding. Difficulty in interpretation of these studies has existed due to methodological limitations including lack of specificity of type of feeding category, lack of clinically defined diagnoses, lack of identification of breastfeeding exposure immediately prior to the onset of illness, and lack of recording of potentially confounding variables, especially socio-economic status[20 124 125 126,127].

Kovar et al,[20] in 1984 evaluated epidemiological and clinical studies concerning the epidemiological evidence for an association between infant feeding and infant health in the USA and other industrialized countries. The questions Kovar raised remain relevant today, in particular whether breastfeeding is associated with lower disease specific morbidity than alternative forms of feeding.

In describing factors associated with infant feeding and presentation and/or admission to hospital, it is important to identify the feeding experience of this group of infants since birth, rather than just at the time of presentation and/or admission. A study in the USA found that in the first month of life 9.5% of infants were weaned due to becoming sick and their inability to breastfeed[91]. Recently, there has been a number of studies of nutritional status of hospitalised infants which have recognised a significant level of undernutrition in this group[114 128] which is understandable considering decreases in appetite, nutrient intake, physical activity and weight loss are common features of acute[41] and/or chronic illness. It is important to recognise associated infant feeding characteristics that contribute to the reasons why infants present or are admitted to hospital in order

provide the basis for optimal nutritional care during the hospital process and planned follow up care post discharge. The aim of this study is to identify whether feeding mode is associated with clinical, demographic and social characteristics of the infant at presentation and or admission of infants to hospital.

Methods

Study Setting

This clinical case series was conducted from March 2013 to October 2013 at The Royal Children's Hospital, a tertiary paediatric specialist centre in Brisbane, Australia. In 2013 there were 24,000 presentations to the emergency department of 0-16 year old children of which 30% were infants aged 0-12 months. Infants who were admitted to the hospital accounted for 16% of overall bed days. Children's Health Services Queensland Human Research Ethics Committee (HREC/12/QRCH/179) and The University of Queensland Medical Research Ethics Committee (Approval Number 2012001150) approved this study (Appendices 1 and 2).

Study population

Parents of infants who presented and/or were admitted to hospital during a six month study period were invited to participate. Participant recruitment took place covering a range of days and time periods, in order to capture a wide spectrum of infants presenting, e.g. as a one-off acute episode or as a frequent presenter with recurrent health issues who presented or were admitted for care. All children aged less than 12 months were eligible to participate, regardless of the reason for presentation. There were no exclusion criteria. As the study was conducted in a tertiary paediatric facility infants from a wide region presented or were admitted for care. The method of data collection was designed to capture infants across all socio demographic groups and was not reliant on parental computer access or written literacy skills.

Survey instruments

A structured face to face interview with parents or carers was developed (Appendix 8). The survey measurement tool was a 40-item questionnaire that contained both fixed-response and open-ended questions about the reason for presentation and or admission to hospital, socio-demographic data and the feeding history from birth. This questionnaire included questions about how the infant had

been fed since birth. The chief investigator (LAW) recruited and administered the questionnaire that had been piloted among a sample of 5 mothers. The pilot results guided expert review of the survey tool and clarified the conditions required for data collection. If the survey could not be completed at the time of presentation or admission a telephone interview was used to complete the survey within one month of the initial contact.

Clinical, demographic and social characteristics

Disease type was recorded using the 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10)[129] using the hospital allocated ICD-10 codes. The ICD-10 classifies morbidity and mortality information for statistical purposes for use in research, health care policy, and health care finance [130]. The ICD-10 is divided initially into 22 chapters as a structured list of codes based on body system or condition. Several infants had multiple codes; in which case the primary code was used. Due to small numbers within some groups some Chapters of the ICD codes were combined with the adjoining Chapter, that being Chapter II and III Neoplasms and Diseases of the blood and blood forming organs and certain disorders involving the immune mechanism, Chapter VII Diseases of the eye and adnexa and Chapter VIII Diseases of the ear and mastoid process, Chapter IX and X Diseases of the circulatory system and Diseases of the respiratory system, Chapter XII and XIII Diseases of the skin and subcutaneous tissue and Diseases of the musculoskeletal system and connective tissue, and Chapter XIX and XX Injury, poisoning and certain other consequences of external causes and External causes of morbidity and mortality.

Socio-economic status (SES) was measured using the Socio-Economic Indexes for Areas (SEIFA), a measure of Relative Disadvantage assessed at the postcode level in Australia [131](ABS 2015). This SEIFA index ranges from 1 to 10, with a low score indicating greatest socioeconomic disadvantage and a high score indicating a relative lack of disadvantage. We divided socioeconomic status into three groups, lowest (decile 1-4), medium (5-7) and highest (8-10). Delivery was grouped as vaginal (including forceps) or caesarean section. Gestation was categorized as pre-term (<37 weeks gestation) or term (37-42 weeks gestation). Age at presentation and or admission was categorized as 0-6, 7-12, 13-18, 19-25, 26-39 and 40-52 weeks. Age at presentation was not corrected for gestational age. Disease duration was recorded according to parent report as ‘since pregnancy’ (which included anytime during the pregnancy e.g. 20 week scan), ‘since birth’, ‘more than seven days ago’ and ‘in the last 7 days’. Feeding at birth and admission was recorded during the interview. Breastfeeding at presentation and or admission to hospital included any breastfeeding or expressed breast milk.

Statistical Analyses

SPSS Version 22 was used for statistical calculations[132] . Summary statistics were used to describe the demographic data. To examine the association between clinical, demographic and social characteristics and presentation and/or admission to hospital, characteristics and infant feeding variables were included in univariable and multivariable logistic regression models. Multivariable models were adjusted for age, socioeconomic status, delivery type, gender, gestation and disease duration at presentation and/or admission of infants to hospital.

Results

Parents of a total of 335 infants were interviewed during the study period, this represented 21% of all infants presenting and/or admitted to hospital during the six month period. Infants were predominantly aged 0-6 weeks (23%), firstborn (44%), male (58%), born by vaginal delivery (54%) and at term gestation (81%) (Table 7.1). Thirty five percent of infants had been admitted to special care nursery or neonatal intensive care nursery immediately or soon after birth. Breastfeeding was initiated in 83% of infants. Sixty percent of the 335 infants were admitted either by initial presentation at the emergency department (ED) or direct admission e.g. pre-planned; with the remaining 40% of infants presenting to the ED not requiring admission. Of the 335 infants, 37% were previously diagnosed with the injury or illness, 26% were known to have a chronic condition. Eleven percent of infants presented or were admitted for a planned procedure and 15% for planned surgery.

Table 7.1 Parent and infant characteristics

Breastfeeding initiation

Table 7.2 illustrates that breastfeeding initiation was significantly associated with infant age at presentation and/or admission, with breastfeeding decreasingly likely to have been initiated as the age at presentation and/or admission increased. Infants delivered by caesarean section were significantly less likely to have initiated breastfeeding after adjustment for potentially confounding variables (odds ratio (OR) 0.5 95% CI 0.2, 1.0) as were preterm infants (<37 weeks gestation) (OR 0.1, 95%CI 0.0,0.3). The other variables investigated were not significant.

Breastfeeding at time of presentation and/or admission

Using the data from breastfeeding at presentation and/ or admission to hospital we calculated odds ratios for disease type, using ICD code Chapter IX Diseases of the circulatory system and Chapter X Diseases of the respiratory system as the reference. The disease group codes of Chapter XII and XIII, Diseases of the skin and subcutaneous tissue and Diseases of the musculoskeletal system and connective tissue, were significantly associated with breastfeeding at presentation and/ or admission after adjusting for potentially confounding variables (OR 0.2 CI 95% 0.0-0.9) (Table 7.2). Diseases recorded within these Chapters were abcesses (n=4), cellulitis(n=2), erythema(n=1) and umbilical discharge(n=1) and the rarer cases of septic arthritis(n=1) and necrotizing fascitis(n=2). These findings were consistent across all age groups. Using data from infants categorised as high SES as the reference, infants from medium SES families were significantly less likely to be breastfed on presentation/admission in multivariable analysis (OR 0.4 95%CI 0.2, 0.8). A similar relationship held invariably, but not multivariable, for infants from low SES backgrounds. When disease duration was considered, with illness noticed in the last seven days the reference group, infants in whom a disease was first noticed at birth were less likely to have breastfeeding initiated (OR 0.3 95% CI 0.1, 0.8 in multivariable analysis). The presence or absence of exclusive breastfeeding was recorded at the time of interview, but regression analysis was not performed due to the low number of infants (16%) identified as exclusively breastfed at the time of presentation and /or admission.

Table 7.2 Breastfeeding at time of presentation and/or admission

Discussion

Summary of Main Results

Breastfeeding initiation

Breastfeeding had been initiated in 96% of infants who presented between 0-6 weeks of age (or were given expressed breast milk from their mother. This number decreased to 87% initiation in the group of infants who were aged 7-12 weeks when they presented and thereafter reached a plateau for remaining age groups within infancy to around 75 - 80% of infants who had initiated breastfeeding. The 2010 Australian national infant feeding survey[133] found that 96% of infants were initially breastfed which is markedly higher than the 83% reported in this cohort. This finding may be that many of these infants or mothers were ill at birth and breastfeeding was not initiated.

Breastfeeding at presentation and/or admission to hospital

Seventy-nine percent of infants who presented between 0-6 weeks of age were breastfeeding or given expressed breastmilk. Therefore during this 6 week period (of which the presentation also occurred) 17% of infants who initially were breastfed commenced alternative feeding with formula. This figure, in those presenting and/or being admitted at 7-12 weeks decreased to 62% breastfeeding and continued to decrease to 25% between 40-52 weeks (any breastfeeding). Therefore of the initial 79%, who had initiated breastfeeding in the 40-52 week age group at presentation age, 25% were continuing to be breastfed at presentation and/or admission, with increasing age of the infant it was less likely that the infant was breastfed. Older infants were more prone to illness/injury when they had not been breastfed. This may partly be explained by infants with chronic illness throughout their life where breastfeeding was not initiated due to initial ill health at birth.

Delivery type and gestational age

The caesarean section rate in Queensland in the 2012/2013 financial year was 33.4 per 100 live births and Australia's overall rate of caesarean sections was higher than the OECD average (32.7 and 26.9 per 100 live births respectively)[134]. Twenty-six percent of infants who presented and/or were admitted were delivered by caesarean section, which was well below the average for Queensland that year but equivalent to the OECD rate[134]. Caesarean delivery was of significance with fewer infants initiating breastfeeding than those born by vaginal delivery. There may be many reasons for a reduced initiation rate including maternal health factors and health of the infant at birth that may be preterm, small for gestational age or have a congenital malformation, which may not preclude breast milk feeding but make it challenging. The combination of unknown factors may make breastfeeding initiation difficult or in some instances contraindicated.

When the illness or injury was first noticed

The limitation to the initiation of breastfeeding may have been discovered at birth with a significant finding both univariably and multivariably on analysis. Whereas the significant finding of the illness/injury first noticed more than seven days ago and current breastfeeding may be an example of breastfeeding being held responsible initially, rather than the early illness, and the feeding changed in the interim to no avail.

Socioeconomic status

Socioeconomic status was not a significant finding in breastfeeding initiation regression analysis but became significant in breastfeeding at presentation/admission, Using data from the infants categorised as high socioeconomic status as the reference, medium socioeconomic status had greater significance on univariable and multivariable analysis than lower SES univariably and no significance multivariably. Breastfeeding is known to reduce with infants from a lower socioeconomic background[83,135]. This analysis is interesting as medium SES was found as significant within breastfeeding at presentation and/or admission, with a lower SES only significant on univariable analysis. These data would suggest that the majority of infants are initially breastfed for at least one feed but are more likely if from a medium to lower socioeconomic group to formula feed which supports what is known[136] but the implications of being ill and/or injured may be lost because of this. In theory, the infant from a lower SES for example, may be at greater risk of becoming unwell due to another confounding variable such as maternal smoking.

International coding of disease

Not underestimating the benefits of breastfeeding to the health of infants and mothers, a clear association was not found between breastfeeding at the time of presentation and/or admission and disease with one exception. This significant finding was that of diseases of the skin and subcutaneous tissue and diseases of the musculoskeletal system and connective tissue where breastfeeding was found to reduce the risk of disease within this group. Considering that the diseases found in this population were abscesses, cellulitis, erythema and umbilical discharge and the rarer cases of septic arthritis and necrotizing fasciitis could all be related to infectious processes, although a small sample, it would suggest the protective effect of breastfeeding in preventing infection and hence risk reduction. Many previous studies have reported the beneficial effect of breastfeeding in reducing infection[25],[93],[18]. Sick infants have the most to gain from optimal feeding yet there is a paucity of studies specifically on feeding in infants presenting or admitted to hospital. The findings of this study would suggest that the choice of infant feeding and characteristics may influence infant presentation and or admission to hospital, with a protective effect of breastfeeding reducing infection in some diagnostic categories.

Strengths and Limitations of study

This study consistently measured mode of feeding to identify if protective effects of breastfeeding in infants presenting and or admitted to hospital could be identified. This paper does not address the severity and duration of the disease which has been highlighted as a problem in previous papers[32,124]. Some authors have argued that duration of disease and hospitalisation are a measure of severity but this is difficult to measure as some hospitals may admit infants whereas others may not with the same level of disease[20,124]. The duration of the illness which can be subjective, was identified when the disease 'was first noticed' in the analysis (Table 7.2) but was not found to be significant. The fact that all parents had serious enough concerns to bring their infant to hospital and with the admission rate for 0-12 months surpassing all other age groups (1-16 years) at this hospital shows the fragility of infant health. Participation was not limited to those typically studied such as respiratory disease and gastrointestinal disease[21 70]as it weakens the effect of all other disease in infancy. Injury was included as infants who have sustained injury are also at risk of impact on their nutritional status, for example nausea, vomiting and headache associated with a skull fracture of which two infants in this study had sustained.

What this means for future practice/research

While there have been recommendations for further studies to be completed in this area,[21,103]. Kovar' had four other questions of interest in relation to allergy, mortality, malnutrition, psychological bonding and intellectual development of which all remain topics of interest in research programs. More recently Naviglio[13] suggested further research on practical and still unanswered questions regarding infant nutrition such as duration and introduction of complementary foods rather than on uncertain remote effects of what is already known. The importance of duration of breastfeeding is becoming increasingly recognised, this is important especially in infants who have presented and or being admitted to hospital.

What is already known on this topic

Breastfeeding initiation rates differ significantly between studies, the WHO definitions of breastfeeding categories are commonly referenced as the method used in studies to define feeding. The difficulty is the interpretation of these definitions by researchers, with little consistency in reporting across data collections.

Preterm gestation and caesarean section impact negatively on initiation of breastfeeding.

What this study adds

Nearly one fifth of infants who initiated breastfeeding had commenced formula feeding within the first six weeks of life.

Older infants were more prone to illness/injury when they had not been breastfed.

The combination of unknown factors may make breastfeeding continuation difficult or in some instances contraindicated.

Table 7.1 Parent and infant characteristics

Variable	Characteristic	Total n= 335 (%)
Parental characteristics		
Maternal age	<20 years	15 (4)
	20-29 years	137 (41)
	30-39 years	166 (50)
	40+ years	16 (5)
	Not known	1 (0)
Education level	Year 9 or less	9 (3)
	Year 10-11	59 (18)
	Completed Year 12 (Secondary School)	71 (21)
	Post secondary education	195 (58)
	Not known	1 (0)
Maternal Partner age	<20 years	8(2)
	20-29 years	96 (29)
	30-39 years	173 (52)
	40+ years	51 (15)
	Not known	7 (2)
Maternal Partner educational level	Year 9 or less	10 (3)
	Year 10-11	63 (19)
	Completed Year 12 (Secondary School)	68 (20)
	Post secondary education	187 (56)
	Not known	7 (2)
Aboriginal Torres Strait Islander (Indigenous)	Yes	18 (5)
	No	317 (95)
Socioeconomic status (SEIFA)	High	210 (63)
	Intermediate	84 (25)
	Low	41 (12)
First language English	Yes	296 (88)
	No	39 (12)
Infant characteristics		
Gender	Male	195 (58)
	Female	140 (42)
Age of infant	0-6 weeks	77 (23)
	7-12 weeks	45 (14)
	13-26 weeks	35 (10)
	27-32 weeks	36 (11)
	33-40 weeks	74 (22)
	41-52 weeks	88 (20)
Birth order	Firstborn	146 (44)
	Second child	110 (33)
	Third child	49 (14)
	4th- 9th child	30 (9)
Gestational age	Pre-term (24-31 weeks)	9 (3)
	Late pre-term (32-36 weeks)	41 (12)
	Term (37-41 Weeks)	270 (81)
	Post - term (42+weeks)	15 (4.5)
Delivery method	Vaginal	182 (54)
	Caesarean Section	86 (26)
	Forceps/ventouse extraction (vacuum)	67 (20)
Birthweight percentile for gestational age	<10th percentile	43 (13)
	Between 10th and 90th percentile	254 (13)
	>90th percentile	37 (11)
	Not known	1 (0)
Admission to SCN/NICU	Yes	118 (35)
Childcare centre attendance	Yes	37 (11)

Table 7.1 Parent and infant characteristics (continued)

Variable	Characteristic	Total n= 335 (%)
Reason for attending		
Presentation to emergency department (ED) but not admitted		136 (40)
Admission to hospital (with or without presentation to ED)		199 (60)
Presenting illness or injury previous diagnosed		125 (37)
Known Chronic condition		88 (26)
Planned procedure		38 (11)
Planned surgery		50 (15)
Initially Breastfeed or EBM		279 (83)
Feeding practice on presentation and/or admission to hospital		
Breastmilk		171 (50)
Exclusive breastfeeding		54 (16)
Receiving formula		223 (67)
Enteral feeding		42 (13)
Other Feeding Data		
Feeding problems		46 (14)
Unsettled behaviour		126 (38)
Fussy feeders		95 (28)
Solid food introduction		167 (50)

Table 7.2 Breastfeeding at time of presentation and/or admission

	Breastfeeding Initiated						Breastfeeding at Presentation/Admission				
	No	**Yes *n*= (%)**	**Univariable OR (95% CI)**	***p* value**	**Multivariable OR (95% CI)**	***p* value**	**Yes *n*= (%)**	**Univariable OR (95% CI)**	***p* value**	**Multivariable OR (95% CI)**	***p* value**
DIAGNOSIS (ICD code)+											
Chapter IX and X Diseases of the circulatory system and Diseases of the respiratory system	71	60 (84.5)	Reference		Reference		40 (56.3)	Reference		Reference	
Chapter 1-Certain infections and parasitic diseases	37	33 (89.2)	1.5 (0.4, 5.1)	0.51	1.6 (0.4, 5.8)	0.49	18 (48.7)	0.7(0.3-1.6)	0.45	0.9 (0.4, 2.1)	0.78
Chapter II and III Neoplasms and Diseases of the blood and blood forming organs and certain disorders involving the immune mechanism	12	10 (83.3)	0.9 (0.2, 4.8)	0.92	1.6 (0.2, 15.3)	0.67	5 (41.7)	0.6(0.2-1.9)	0.35	0.8 (0.2, 3.2)	0.73
Chapter IV Endocrine, nutritional and metabolic diseases	8	8 (100.0)	n/c	n/c	n/c	n/c	5 (62.5)	1.3(0. 3-5.8	0.74	1.6 (0.3, 8.6)	0.61
Chapter VI Diseases of the nervous system	6	4 (66.7)	0.4 (0.1, 2.3)	0.28	0.4 (0.0, 8.9)	0.54	3 (50.0)	0. 8 (0.1-4.1)	0.76	0.4 (0.1, 2.9)	0.38
Chapter VII and VIII Diseases of the eye & adnexa and diseases of the ear and mastoid process	16	14 (87.5)	1.3 (0.3, 6.5)	0.76	1.5 (0.2, 14.3)	0.73	10 (62.5)	1.3 (0.4-3.9)	0.65	0.6 (0.2, 2.5)	0.52
Chapter XI Diseases of the digestive system	23	17 (73.9)	0.5 (0.2, 1.6)	0.26	0.7 (0.2, 3.0)	0.62	12(52.2)	0.8 (0.3-2.2)	0.73	0.9 (0.3, 2.7)	0.83
Chapter XII and XIII Diseases of the skin and subcutaneous tissue and Diseases of the musculoskeletal system and connective tissue.	16	13 (81.3)	0.8 (0.2, 3.3)	0.75	0.6 (0.1, 3.3)	0.53	4 (25.0)	0.3(0.1-0.9)	0.03	0.2 (0.0, 0.9)	0.03
Chapter XIV Diseases of the genitourinary system	10	7 (70.0)	0.4 (0.1, 1.9)	0.27	1.0 (0.2, 6.0)	0.99	5 (50.0)	0.8 (0.2-2.9)	0.71	1.2 (0.3, 5.4)	0.77
Chapter XVI Certain conditions originating in the perinatal period	15	15 (100.0)	n/c	n/c	n/c	n/c	12 (80.0)	3.1 (0.8-11.9)	0.1	0.7 (0.1, 4.1)	0.74
Chapter XVII Congenital malformations, deformations and chromosomal abnormalities	43	36 (83.7)	0.9 (0.3, 2.7)	0.91	1.3 (0.3, 5.6)	0.77	22 (51.2)	0.8 (0.4-1.7)	0.59	0.8 (0.4, 2.0)	0.7
Chapter XVIII Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified	24	18 (75.0)	0.6 (0.2, 1.7)	0.3	0.4 (0.1, 1.5)	0.17	12 (50.0)	0.8(0.3-2.0)	0.59	0.6 (0.2, 1.6)	0.29
Chapter XIX and XX Injury, poisoning and certain other consequences of external causes and External causes of morbidity and mortality	30	23 (76.7)	0.6 (0.2, 1.7)	0.35	0.7 (0.2, 2.5)	0.59	11 (36.7)	0.4 (0. 2-1.1)	0.07	0.5 (0.2, 1.3)	0.14
Chapter XXI Factors influencing health status and contact with health services	22	19 (86.4)	1.2 (0.3, 4.6)	0.83	1.4 (0.2, 7.9)	0.71	11 (50.0)	0.8 (0.3-2.0)	0.6	0.8 (0.3, 2.2)	0.6
SOCIO-ECONOMIC STATUS											
High	210	181 (86.2)	Reference		Reference		123 (58.6)	Reference		Reference	
Medium	84	32 (78.1)	0.6 (0.2, 1.3)	0.19	0.8 (0.3, 2.1)	0.6	33 (39.3)	0.5 (0.3, 0.8)	0.003	0.4 (0.2, 0.8)	0.008
Low	41	66 (78.6)	0.6 (0.3, 1.1)	0.11	0.7 (0.3, 1.5)	0.36	15 (36.6)	0.4 (0.2, 0.8)	0.01	0.5 (0.2, 1.2)	0.15

Table 7.2 Breastfeeding at time of presentation and/or admission (continued)

	Breastfeeding Initiated						Breastfeeding at Presentation/Admission				
	No	**Yes *n*= (%)**	**Univariable OR (95% CI)**	***p* value**	**Multivariable OR (95% CI)**	***p* value**	**Yes *n*= (%)**	**Univariable OR (95% CI)**	***p* value**	**Multivariable OR (95% CI)**	***p* value**
DELIVERY											
Delivery=1	249	214 (85.9)	Reference				130 (52.2)	Reference		Reference	
Delivery=2	86	65 (75.6)	0.5 (0.3, 0.9)	0.03	0.5 (0.2, 1.0)	0.05	41 (47.7)	0.8 (0.5, 1.4)	0.47	1.0 (0.5, 1.7)	0.92
GENDER											
Gender=1	195	160 (82.1)	Reference				98 (50.3)	Reference		Reference	
Gender=2	140	119 (85.0)	1.2 (0.7, 2.2)	0.48	1.4 (0.7, 2.8)	0.3	73 (52.1)	1.1 (0.7, 1.7)	0.73	1.3 (0.8, 2.2)	0.25
GESTATION											
37-41 weeks	285	251 (88.1)	Reference		Reference		151 (53.0)	Reference		Reference	
Up to 36 weeks	50	28 (56.0)	0.2 (0.1, 0.3)	<0.001	0.1 (0.0, 0.3)	<0.001	20 (40.0)	0.6 (0.3, 1.1)	0.09	0.6 (0.3, 1.2)	0.14
AGE											
0-6 weeks	77	74 (96.1)	Reference								
7-12 weeks	45	39 (86.7)	0.3 (0.1, 1.1)	0.07	0.2 (0.0, 1.3)	0.09	61 (79.2)	Reference		Reference	
13-18 weeks	35	28 (80.0)	0.2 (0.0, 0.7)	0.01	0.2 (0.0, 1.1)	0.07	28 (62.2)	0.4 (0.2, 1.0)	0.04	0.4 (0.2, 1.0)	0.05
19-25 weeks	36	28 (77.8)	0.1 (0.0, 0.6)	0.006	0.1 (0.0, 0.6)	0.009	18 (51.4)	0.3 (0.1, 0.7)	0.004	0.3 (0.1, 0.7)	0.009
26-39 weeks	74	56 (75.7)	0.1 (0.0, 0.4)	0.001	0.1 (0.0, 0.6)	0.008	20 (55.6)	0.3 (0.1, 0.8)	0.01	0.3 (0.1, 0.9)	0.02
40-52 weeks	68	54 (79.4)	0.2 (0.0, 0.6)	0.005	0.1 (0.0, 0.6)	0.007	27 (36.5)	0.2 (0.1, 0.3)	<0.001	0.2 (0.1, 0.4)	<0.001
FIRST NOTICED											
Last 7 days	185	159 (86.0)	Reference		Reference		104 (56.2)	Reference		Reference	
More than 7 days	73	61 (83.6)	0.8 (0.4, 1.8)	0.63	1.1 (0.4, 2.8)	0.9	30 (41.1)	0.5 (0.3, 0.9)	0.03	0.9 (0.4, 1.8)	0.71
Since birth	55	39 (70.9)	0.4 (0.2, 0.8)	0.01	0.3 (0.1, 0.8)	0.03	24 (43.6)	0.6 (0.3, 1.1)	0.1	0.6 (0.3, 1.6)	0.36
Since pregnancy	22	20 (90.9)	1.6 (0.4, 7.4)	0.52	1.3 (0.2, 9.2)	0.81	13 (59.1)	1.1 (0.5, 2.8)	0.8	1.6 (0.4, 6.1)	0.5

CHAPTER 8: INFANT FEEDING DURING ADMISSION

8.1 Introduction

Infant feeding can be disrupted by admission to hospital. This includes events that preceded admission including age of the infant, gender, maternal chronic illness, maternal smoking, disease duration and length of admission to hospital. The aim of this study is to explore what factors contribute to a potential feeding change of infants either before or during the hospital admission.

8.2 Manuscript details

Williams LA, Ware RS, Davies PSW. Getting the real picture of the infant admitted to hospital: breastfeeding and health. Submitted for publication May 2015.

8.3 Getting the real picture of the infant admitted to hospital: breastfeeding and health

Lesley A Williams, Robert S Ware, Peter SW Davies

Aim: Infant feeding can be disrupted by admission to hospital. The aim of this study was to explore the factors that affect breastfeeding in hospital and change in feeding of infants who were admitted to hospital.

Methods: A cross-sectional study was conducted at a tertiary paediatric hospital in Brisbane, Australia, between March 2013 and October 2013. A questionnaire based survey of parent's ascertained information about feeding, health and sociodemographic characteristics of infants admitted to hospital during their first year of life. The association between infant and maternal characteristics and feeding mode was investigated.

Results: Parents of 75 infants admitted to hospital were surveyed. 27% of the infants were aged 33-41 weeks, 73% were male, 85% were born at term and 79% initiated breastfeeding at birth. Older infants and infants of mothers who smoked were significantly less likely to be breastfed. Six infants were weaned as a consequence of the condition they were admitted for.

Conclusion: Hospitalised infants were breastfed or receiving breastmilk from their mother in the over 26 week age group in a similar rate to that found in the wider Australian population. Mothers who smoked were less likely to breastfeed their infant. Maternal health and the hospital experience for infants requires further exploration to promote optimal nutrition for hospitalised infants.

Introduction

Infants are over represented in hospital admissions worldwide[21,33,68,69]. Infants admitted to the Royal Children's Hospital, a tertiary paediatric hospital in Brisbane, Australia comprised 9.9% of all admissions and represented nearly 15.9% of overall bed days in the 2012-2013 financial year.

Infant feeding can be disrupted by admission to hospital and infants are known to be at greatest risk of malnutrition in hospital[37,112,114,115]. The disruption of infant feeding during hospital admission occurs in two different ways, firstly the new environment of the hospital where there is a change of routine, noise, unknown people, and a different physical environment for feeding and sleeping for the infant and mother. Secondly, the physiological effect that the reason for admission, which could be illness, injury, planned surgery or treatment, has on the infant's body can either change infant feeding or create a need to change feeding patterns. The effect of being ill or injured and the associated treatment may alter the mode, type and frequency of feeding, and alter the infant's nutritional state. Infants with a chronic disorder may be most at risk of disruption to feeding. Infants who are admitted to hospital may have feeding disruption due to pre-procedural fasting which may involve anaesthesia and oral intake restriction post anaesthetic.

Maternal factors may also impact the feeding of hospitalised infants. Maternal smoking is a factor that is associated with decreased breastfeeding rates[2,83,93], and while smoking is acknowledged as detrimental to infant health it is rarely described in studies of hospitalised infants. The continuation of breastfeeding in the hospital setting may also be affected by chronic maternal illness. There is a paucity of studies that have identified an infant's feeding history from birth until admission to hospital and identified associated factors that impede or improve optimal feeding outcomes.

Events that precede admission can disrupt infant feeding during admission to hospital including maternal chronic illness and disease duration. The aim of this study is to explore what factors contribute to a potential feeding change of infants either before or during the hospital admission.

Methods

Study Setting and Population

This cross-sectional study was conducted from March 2013 to October 2013 at The Royal Children's Hospital, a tertiary paediatric specialist centre in Brisbane, Australia. Parents of infants who were admitted to hospital during a six month study period were invited to participate. Participants were interviewed face to face at recruitment. Participant recruitment took place covering a range of days and time periods, in order to capture a wide spectrum of infants who were admitted, e.g. as a one-off surgical admission or as a medical admission with recurrent health issues who was admitted for care. All children admitted to the Royal Children's Hospital aged less than 12 months were eligible to participate, regardless of the reason for admission. The method of data collection was designed to capture infants across all social and demographic groups and was not reliant on parental computer access or written literacy skills. There were no exclusion criteria. Children's Health Services Queensland Human Research Ethics Committee (HREC/12/QRCH/179) and The University of Queensland Medical Research Ethics Committee (Approval Number 2012001150) approved this study.

Survey Instrument

At recruitment a structured face to face interview with parents or carers was conducted using a 46-item questionnaire that contained both fixed-response and open-ended questions (Appendices 9 and 10). Demographic, social and clinical information was collected, including the reason for admission to hospital, whether admission was emergency or planned, pre-procedural fasting times and the feeding history from birth. Six questions relating to the admission were included. The chief investigator (LAW) recruited and administered the questionnaire. If the survey could not be completed at the time of presentation or admission a telephone interview was used to complete this survey within one month of the initial contact.

Outcome variable

The primary outcome of interest was infant breastfeeding. This was measured at admission to hospital which was recorded by carer report during the interview. Feeding was categorised as

breastfeeding or not breastfeeding. Breastfeeding at admission to hospital included any breastfeeding or expressed breast milk.

Explanatory variables

Demographic, social and clinical infant and maternal characteristics were recorded. Age at admission was categorised as 0-12, 13-25, or 26+weeks. Age at admission was not corrected for gestational age. Disease duration was recorded according to parent report as 'since pregnancy and at birth' (which included anytime during the pregnancy e.g. 20 week scan and at birth), and 'since birth', days admitted to hospital categorised as 1-7 days and greater than 7 days. Other variables recorded included gender, maternal chronic illness and maternal smoking.

Statistical Analyses

SPSS Version 22 and Stata version 12.0 were used for statistical calculations. Summary statistics were used to describe the demographic data. To examine the association between clinical, demographic and social characteristics and breastfeeding, univariable and multivariable logistic regression models were run. Multivariable models were adjusted for age and gender. We calculated odds ratios and 95% confidence intervals.

Results

Parents of a total of 75 admitted infants were interviewed during the study period. Twenty seven percent were aged older than 26 weeks, firstborn (37%), male (73%), term gestation (85%) born by vaginal delivery (77%) and a birthweight between 10th and 90th percentile (75%). Thirty seven percent of infants had been admitted to either an intensive care or special care nursery following birth. Twenty nine percent of infants were admitted for planned surgery or a planned procedure (12%). Seventy nine percent of infants were initially breastfed and 56% continued to be breastfed at admission.

Table 8.1 Demographic, social and clinical characteristics of 75 infants and their mothers at hospital admission

The age of infants older than 26 weeks was found to be significantly associated with feeding mode, with older infants less likely to be breastfed (OR 0.1 95% CI 0.0, 0.5). Mothers who smoked

cigarettes were significantly less likely to breastfeed their infants at admission (OR 0.2 95% CI 0.0, 1.0) but this effect was attenuated after adjusting for infant age and gender. The odds of an infant with chronic disease being breastfed were 5 times less than for their peers, but the finding was not significant.

Table 8.2 Association between infant and maternal characteristics and mode of feeding at admission. Multivariable analysis adjusted for age and gender.

Six infants were identified as being weaned as a consequence of the condition they were admitted for. The reasons for weaning were identified as cleft palate (*n*=2), respiratory illness (*n*=1), head injury (*n*=1), diabetes insipidus (*n*=1), and recurrent infant ear infection (*n*=1). The infants were all weaned during the first six months of life.

Table 8.1: Demographic, social and clinical characteristics of 75 infants and their mothers at hospital admission

Parental characteristics		**Total *n*= 75 (%)**	**Perinatal and infant characteristics**		**Total *n*= 75 (%)**
Maternal age	<20 years	3 (4)	Gender	Male	55 (73)
	20-29 years	30 (40)		Female	20 (27)
	30-39 years	39 (52)	Age of infant	0-6 weeks	15 (20)
	40+ years	3 (4)		7-12 weeks	8 (11)
Education level	Year 9 or less	4 (5)		13-26 weeks	9 (12)
	Year 10-11	13 (17)		27-32 weeks	11 (14)
	Completed Year 12	16 (21)		33-40 weeks	20 (27)
	Post secondary education	42 (56)		41-52 weeks	12 (16)
Maternal Partner age	<20 years	2 (3)	Birth order	Firstborn	28 (37)
	20-29 years	22 (29)		Second child	22 (29)
	30-39 years	41 (55)		Third child	17 (23)
	40+ years	9 (12)		4th- 9th child	8 (11)
	Not known	1 (1)	Gestational age	Pre-term (24-36 weeks)	11 (15)
Maternal Partner educational level	Year 9 or less	4 (5)		Term (37-42 weeks)	64 (85)
	Year 10-11	16 (21)	Delivery method	Vaginal	58 (77)
	Completed Year 12	14 (19)		Caesarean Section	17 (23)
	Post-secondary education	41 (55)	Birthweight percentile for gestational age	<10th percentile	10 (13)
ATSI (Indigenous)	Yes	7 (9)		10th to 90th percentile	56 (75)
	No	68 (91)		>90th percentile	9 (12)
Socioeconomic status(SEIFA)	High	33 (44)	Admission to SCN/NICU	Yes	28 (37)
	Intermediate	29 (39)	Planned surgical admission	Yes	22 (29)
	Low	13 (17)	Planned procedure admission	Yes	9 (12)
First language English	Yes	70 (93)	Initially Breastfed or EBM	Yes	59 (79)
	No	5 (7)	Breastfed at admission	Yes	42 (56)
Maternal chronic illness	Yes	26 (35)			
Maternal smoking	Yes	15 (20)			

*Year 12 = Secondary school
**ATSI = Aboriginal and Torres Strait Islander

Table 8.2: Association between infant and maternal characteristics and mode of feeding at admission.
Multivariable analysis adjusted for age and gender.

Characteristic	**Number (*n*)**	**Breastfed (*n*= %)**	**Univariable OR (95% CI) *p* value**	**Multivariable OR (95% CI) *p* value**
Age				
0-12 weeks	23	19 (82.6)	1.0	1.0
13-25 weeks	20	11 (55)	0.3 (0.1,1.0); 0.06	0.3 (0.6,1.1);0.07
26 + weeks	32	12 (37.5)	0.1 (0.0, 0.5);0.002	0.1 (0.0,1.1); 0.00
Gender				
Male	55	32 (58.2)	1.0	1.0
Female	20	10 (50.0)	0.7 (0.3,2.0); 0.53	0.6 (0.2,2.1);0.5
Maternal chronic illness				
No	48	29 (60.4)	1.0	1.0
Yes	27	13 (48.1)	0.6 (0.2,1.6);0.3	0.4 (0.1,1.4);0.1
Maternal smoking				
No	60	37 (61.6)	1.0	1.0
Yes	15	5 (33.3)	0.2 (0.0,1.0); 0.05	0.4 (0.1,1.4);0.1
First noticed illness				
During pregnancy, at birth	44	27 (61.3)	1.0	1.0
Since birth	31	15 (48.3)	0.59 (0.2,1.4);0.2	0.6 (0.2,1.8);0.4
Infant chronic illness				
No	32	21 (65.6)	1.0	1.0
Yes	39	18 (46.1)	0.2 (0.2,1.1) ; 0.10	0.6 (0.2,2.0);0.5
Days admitted to hospital				
1-7 days	62	35 (56.4)	1.0	1.0
8+ days	13	7 (53.8)	0.5 (0.2,2.9); 0.86	0.7 (0.2,2.9);0.7

Discussion

Infant characteristics

Thirty eight percent of infants older than 26 weeks who were admitted were breastfed or receiving expressed breastmilk from their mother. Over half (52%) of infants in this cohort had been diagnosed with a chronic illness such as cystic fibrosis which may have impacted on their feeding. There is a paucity of literature that describes chronicity of illness in infancy, including treatment required for congenital conditions and any relationship to infant feeding. The admitted infants included in this study may represent a vulnerable population as while 15% were preterm, 28 (37%) were admitted to a special care or intensive care nursery post birth.

Although this study focused on hospitalised infants, the overall breastfeeding rate is similar to that found in the wider Australian population. The 2010 Australian National Feeding Survey[137] found that 42.2 percent of infants aged 7-12 months received any breastmilk, which is not dissimilar to the finding in this study, despite the fact that this cohort were hospitalised infants. The alternative reason, as to why this may be similar to the national average, is because mothers of admitted infants most likely want to do their best for their infant with a chronic or long term illness. This is less disruptive when the infant has a short length of admission for surgery and procedures as opposed to long hospitalisation which make breastfeeding more tenuous.

Maternal characteristics

Smoking during pregnancy is associated with poorer birth outcomes[138]. 'Australia's mothers and babies 2012'[139] survey reported that, nationally, 9.1% of women smoked after 20 weeks of pregnancy. Compared to the study findings, twenty percent of mothers of infants who were admitted to hospital in this study reported smoking. Maternal smoking is related to reduced rates of initiation and length of breastfeeding infants (140). Maternal smoking was a significant finding in univariable analysis OR 0.2 CI 95% (0.0,1.0) as to mothers not breastfeeding their infant at admission to hospital. Smoking was a significant finding with this group of mothers less likely to breastfeed their infant. As maternal smoking is known to have health implications for infants, this is a major concern. Many health interventions target maternal smoking but more needs to be done.

Thirty five percent of mothers reported a chronic health condition, although not statistically significant, mothers with chronic conditions were less likely to be breastfeeding at admission. Clinically, this is of significance in two respects, firstly, is the mother's health condition related to the infants reason for admission, for example, asthma. Women with poorly controlled asthma in pregnancy are at risk of experiencing pregnancy induced hypertension and pre-eclampsia. They are also at increased risk of having infants that are premature or small for gestational age[140]. The second effect is that the mother might not feel well enough to breastfeed or be advised against breastfeeding because of the chronic condition. While demographic characteristics of mothers have been collected in other studies, for example, Australia's mothers and babies 2012, there are few studies of maternal health post parturition. The relationship between maternal chronic illness and infant chronic illness or any illness requires further investigation. With the increasing study of epigenetics[67,141,142], for example in the area of obesity, maternal health not only maternal nutrition during pregnancy needs to be further examined.

Six infants were weaned as a direct result of their illness/injury episode. Examples of why the infants were weaned as a consequence of the condition they were admitted for included congenital abnormality undiagnosed until birth (cleft palate). This usually requires long term expression of breastmilk until the palate is repaired, which may be daunting to a first-time mother. Respiratory illness, where the child has been unwell for days, has difficulty with attachment because of the illness and an extremely tired mother due to caring for her sick infant, can lead to weaning. Infants need individualised assessment and mothers need support to maintain breastfeeding or expression of breastmilk in these situations. The infants identified in the study were all weaned during the first six months of life.

Breastfeeding an infant is dependent upon many factors in the hospital setting. Maintenance of breastfeeding is more easily accomplished in a planned one day stay for a surgical intervention than an emergency admission, and for a long term illness such as cystic fibrosis where feeding needs to be carefully monitored. The expectations placed on mothers in the hospital setting to provide breastmilk for their child can be overwhelming and the longer the duration of hospitalisation the more difficult to continue with providing breast milk. Health professionals in the hospital setting can be oblivious to the level of distress a mother has in this setting, whether for a short stay or a prolonged stay, and the disruption to infant feeding. This disruption may lead to earlier weaning from breastfeeding than planned.

The strengths of the study are the face to face nature of data collection with parents while their infant was in hospital. As far as we know it is one of the first studies to focus on feeding during admission to hospital and the factors infrequently considered in breastfeeding duration. This study did not have exclusion criteria other than infants less than one year of age and was not focused on a particular admission category. The key limitation of this study is that the sample size may lead to a lack of power to detect some outcomes.

Areas identified in this paper where there is a need for future research are, first, to identify maternal characteristics that impede initiation or continuation of breastfeeding for infants admitted to hospital. Second, further exploration of the hospital experience, which can disrupt infant feeding during admission, is needed. The paediatric hospital is a unique environment where optimal feeding for the individual infant can be promoted.

CHAPTER 9: DISCUSSION

This chapter provides a comprehensive discussion of the thesis as a whole, extending beyond the individual discussions incorporated at the end of each of the previous chapters and endeavours to draw the individual chapters together.

9.1 Research Problem

With the increasing level of knowledge of the importance of nutrition in early life and acknowledging that sick and vulnerable infants have the most to gain from optimal feeding, there is a need for improved understanding of an infant's feeding history on presentation and/ or admission to hospital. This thesis aimed to identify, explore and clarify the infant's, maternal and sociodemographic factors that may influence feeding before the infant presents to hospital, the impact of feeding on the reason for presentation and the factors that impact feeding in hospital.

9.2 Summary of research in relation to aims

The first aim of the study was to identify and summarise the evidence regarding the extent to which infant feeding influences hospitalisation for illness in infants. Infant feeding was not related to the reason for presentation and/ or admission to hospital for some illness in infants, which was not consistent with the null hypothesis. The review of the literature identified that data relating to infants presenting to hospital in previous studies have been linked to clinical diagnoses and admission to hospital in many studies and reviews. Infant feeding was found to have strong association with some illness requiring hospitalisation in infancy in developed countries[2,11,21,69,93]. The systematic review of infant feeding experience and hospitalisation in developed countries found that it was not clear whether feeding was causally associated with infant hospitalisations. The literature review (Chapter 2) and the systematic review (Publication in Chapter 4 – Williams LA, Davies PSW, Boyd R, David M, Ware RS A systematic review of infant feeding experience and hospitalisation in developed countries. Acta Paediatrica, 2014; 103,131-138 doi: 10.1111/apa12477) form the evidence base of this study.

The literature review revealed a paucity of studies that included the recording of feeding history of infants who had presented and/ or being admitted to hospital. The second aim, as an outcome of the literature review was therefore to identify the recording of infant feeding history in the medical

record of an infant who presents and/or is admitted to hospital by a chart audit at the Royal Children's Hospital, Brisbane. Consistent with the null hypothesis, the chart audit to identify the recording of feeding history found that a comprehensive feeding history was not recorded on many occasions of infant presentation and/or admission to hospital. The findings from the chart audit suggest that feeding is infrequently investigated as a potential underlying causal reason for presentation at a paediatric hospital (Chapter 5- Williams LA, Ware RS, Davies PSW. Hospital, infants and feeding: the importance of audit. Journal of Paediatrics and Child Health. 2015 doi:10.1111/jpc.12824)

The literature review also identified studies that suggested that infants who presented and or were admitted to hospital were at risk of suboptimal nutritional status at that time. Consequently, the chart audit to review feeding history recording was designed to also include the recording of measurements of growth. The third aim, therefore, was to identify the recording of growth in the medical record of an infant who presents and/ or is admitted to hospital. Consistent with the null hypothesis, the chart audit found that growth measurements were not recorded on many occasions of infant presentation and/or admission to hospital. Assessment of growth as a marker of illness or nutritional deficit has been poorly assessed in this group (Chapter 6 Williams LA, Ware RS, Davies PSW Back to basics: An audit of measurement of infant growth at presentation to hospital. Australian Health Review 2015 doi: 10.1071/AH14165)

Corroborating that feeding and growth were poorly recorded in infant medical charts; the next phase of the study design was completed taking this into consideration. This parental questionnaire phase provided the data for the fourth aim, which was to establish if a relationship exists between feeding and sociodemographic characteristics and disease type of infants who present and/ or are admitted to hospital. (Publication in Chapter 7. Citation: Characteristics of infants who present to a paediatric hospital: feeding history). The predictors (independent variables) in this phase of the study were chosen to reflect clinical, demographic and social characteristics of the infant at presentation and/or admission to hospital. The selection of the predictors was informed by (a) a systematic review of the literature; (b) and data availability. The findings from this phase of the study, not consistent with the null hypothesis, would suggest that the choice of infant feeding, sociodemographic characteristics and disease category does influence infant presentation and/or admission to hospital. Breastfeeding at the time of presentation and/or admission was significantly associated with diseases of the skin and subcutaneous tissue and diseases of the musculoskeletal system and connective tissue, with not being higher SES, and with having longer disease duration.

The final aim of the study was to establish if a relationship exists between breastfeeding duration and the reason why infants present and/ or are admitted to hospital is first noticed. The parental questionnaire phase of the study provided the data for this final aim of this study (Chapter 8 – Citation "Getting the real picture of the infant admitted to hospital: breastfeeding and health.").The finding from this phase of the study, not consistent with the null hypothesis is that breastfeeding duration is related to hospital admission. Breastfeeding duration was significantly associated with older infants (26-52 weeks) less likely to breastfeed their infants. The odds of an infant with chronic disease being breastfed were five times less than for their peers, but this finding was not significant.

9.3 Synthesis of research findings

Past studies on feeding in relation to ill health in infancy lack consistent measurement of breastfeeding and have focused on specific diagnostic groups.

The results of the literature review and the systematic review highlighted the inconsistency of recording of infant feeding. This is very important, particularly when past research has been used to inform and direct policy for the World Health Organization and government agencies about the perceived benefits of particular practices of infant feeding[18,143,144]. As concerning, is the continuation of describing infant feeding inconsistently in studies. Considering that in 1984, Kovar and colleagues[20] questioned the epidemiological evidence supporting association between infant feeding and infant health, of which much remains unanswered today. Bauchner and colleagues[29] in 1986, questioned the generalisability of the same association and their introduction of four methodological standards that related to both internal and external validity, despite this there has been little change in consistency of studies in three decades. The focus of studies on particular illness groups such as respiratory and gastrointestinal illness and infant feeding in developed countries detract from the myriad other reasons why infants present and/ or are admitted to hospital that have feeding implications.

Re-examining health outcomes previously thought to be associated with breastfeeding is important. This will allow more complete quantification of benefits derived from breastfeeding related health promotion efforts, especially in terms of infants presenting and/ or admitted to hospital. Of more benefit may be realigning the focus of research to identify practical ways to support maintenance of at least some breastfeeding for a longer duration. Increased duration of any breastfeeding of any

amount may benefit in particular, infants who present and/ or are admitted to hospital, if it is deemed beneficial in their individual situations.

Infant feeding and growth is poorly assessed in the hospital environment.

In a hierarchy of human needs food is the greatest need. The literature review and the chart audit revealed the poor assessment of feeding and growth of infants in the hospital setting. Nutritional status of infants in this setting in developed countries is increasingly receiving recognition with under and over nutrition featuring. The exposure of poor recording of infant feeding history and of anthropometric assessment in this environment then leads to more questions rather than what has been found.

The first question in the hospital environment is: Who is responsible for anthropometric assessment of infants?

Is this determined by professional roles or industrial awards or is it defined by the education in weighing, measuring and recording that has been formally received?

Within the hospital setting management structure, who decides which infants are to be weighed and measured (exclusion criteria would be critically ill or injured child) and at what stage of their presentation and/ or admission?

The questions, which apply to the recording of feeding history of infants are similar, as in, who is responsible and who is qualified to complete the feeding history. The health professionals within the hospital environment who are most likely to be educated within these areas are medical and nursing staff, and dietitians. It is questionable as to the practical education and application that is received during professional training in the area of paediatric growth monitoring and feeding assessment here in Australia. Until these questions are answered and addressed they may be little improvement in the recording of infant feeding history and growth in the hospital setting. If recording is not occurring it can be assumed that the measurement is not being performed and feeding history is not achieved. The difficulty in assuming that the diagnosis is indicative of an infant's expected growth trajectory is that recent studies have found that clinicians had difficulty visually assessing malnutrition in children[145,146]. The infant presenting with trauma does not

preclude having poor or excessive growth. Feeding history and growth is important to identify in all infants presenting at the emergency department or admitted to hospital (except initially in life threatening presentation). All infants should be assessed for age appropriate growth.

Improvement in both recording of the feeding history and growth, aside from the obvious health outcomes for the infant, can be linked to economic savings for the health system. The economic savings result from early identification and management of feeding problems, early diagnosis, treatment and a reduction in presentation and/or admission to hospital during infancy. Under or over nutrition can be identified and treated with a reduction in long term consequences. Importantly, the infant feeding history may expose the reason for firstly presentation, negating the need for further exploration of the presenting problem and secondly inform nutritional advice to the mother and nutritional care during an admission phase.

The practical issues of measurement, which are rarely addressed in studies and the chart audit, found minimal recording of whether the infant was 'bare weighed'. Understanding the effect of an infant being clothed or in a wet nappy when weighed, which can significantly alter the result is important to record. This is extremely important in this age group when using weight as a determinant of medication dose.

The most likely reason for the more frequent recording of weight in the chart audit was most likely due to this assessment for correct medication dose. Bare weighing also provides an opportunity for a close inspection of the infant while undressed including skin integrity, tissue turgor and abnormality.

Infant feeding in the hospital setting is much broader than ever versus never breastfed.

The association between infant feeding and infant health in developed countries has been the focus of much research[11,20]. Previous studies in this area have primarily focused on assessing the risks and benefits of the type of infant feeding in relationship to illness, primarily that of breastfeeding versus formula feeding[19,20,32,33,69,103,147]. In the hospital setting, as this study has found, it is important to identify the feeding experience of this group of infants since birth, rather than just at the time of presentation and/ or admission. Recognising the importance of the feeding experience in the hospital setting, breastfeeding initiation and breastfeeding at presentation and /or admission to hospital was found to be the most consistent way of reporting. Firstly, this comparison replicates the systematic review analysis to maintain consistency in reporting[127]. Secondly, the World Health

Organization (WHO) definitions of breast feeding commonly referenced as the method used in studies to define feeding have had inconsistent reporting[127]. Therefore it was appropriate to continue to use the measurement of identifying infants who had initiated breastfeeding and the infants who were continuing to receive any breast milk at presentation and /or admission to hospital. Many variations of feeding practices were reported in infancy in this cohort, for example, breast feeding, multiple variations of non-human milk and formula as well as solid food intake. Initially every effort was used to accurately record feeding; it became difficult, as infants are introduced to a wide variety of non-human milk, formula and solid food. Such diversity of feeding exemplifies that each infant should have a feeding history recorded on presentation and /or admission to hospital to identify the role of infant feeding in the individual infant's reason for presentation and / or admission to hospital. Reporting of initiation and current breastfeeding practice has greater accuracy than using descriptions of exclusive, predominant or complimentary feeding when there is commonly misinterpretation of the criteria for these definitions.

In a hospital setting, individual infant feeding history should establish not just the mode of feeding, as in breast, bottle or enteral feeding, but the type of feed is it breast milk, formula or even rice or cow's milk? Is the infant drinking other fluids such as water or fruit juice? If the infant is drinking formula, how long has the infant being weaned from the breast or was breastfeeding never initiated? Is the formula the infant is drinking now the only type of formula they have had and what the reasons behind the change were.

Understanding how the mother is making the formula is also important in ensuring the infant is receiving the correct composition. If the infant is enterally fed it is important to understand how the mother has been managing the feeds and identifying any difficulties with feeding. Difficulties in feeding should be assessed in breast and bottle fed infants as well and direct the need for assessment of underlying disease or motor dysfunction. The frequency of feeding is important in understanding if feeding is implicated in the reason for presentation and or admission. An infant who apparently is not waking easily for feeds at a regular time and having difficulty attaching and sucking requires urgent assessment.

Complementary feeding is rarely mentioned in studies of infant feeding and presentation and or admission to hospital and was not well documented in the chart audit phase of this study. It is important to recognise if the reason for presentation and/ or admission is related to the timing of the introduction of complementary feeding and also at what age were complementary foods first given. If solid food has been introduced earlier than the national guidelines suggest, why was this done?

Late introduction of solid food also has implications as far as nutrients available to the infant, especially that of iron. The assessment of feeding in conjunction with growth measurements is an indicator of the infant's health status.

9.4 Main messages and clinical implications

The following section details the primary messages that can be derived from this work, and the implications for clinical practice for infants who present and or admitted to hospital.

Measurements of growth

This work has demonstrated that growth is poorly assessed in a hospital environment. Plotting of growth curves on appropriate charts remains the simplest way to assess nutritional status in children[35].

In recent years, tools have been developed in hospital settings to assess paediatric nutritional risk[40,42,97] in response to recognition of the level of malnutrition in the hospital paediatric population. With increasing demands on clinician's time, rather than implementing something new, the need is there first to ensure that the simplest way to assess infant nutritional status is completed and is accurate. The availability of appropriate equipment to weigh and measure is essential with regular calibration scheduled. The importance of understanding who is responsible for weighing and measuring infants in the different hospital environments needs to be assessed to improve practice. The professional education of clinicians who are working in a paediatric environment needs to include the importance of how to accurately weigh and measure infants as well as the practical skill. All health professionals in developed countries should have the knowledge, skills and equipment to capably perform these skills. Identification and treatment of malnutrition and growth deficits are cost effective methods of optimising infant health.

This is the first study of an audit focusing on infants (0-12 months age) who are over represented group within paediatric hospital presentations and admissions. This research has confirmed by audit that assessment of infant growth by weight and measurement in a hospital setting has been poorly assessed in this group.

Recording of feeding history

This work has demonstrated that a comprehensive infant feeding history was not recorded in the hospital environment on presentation and/ or admission. This study suggests that feeding is infrequently investigated as a potential underlying causal reason for presentation at the emergency department at a paediatric hospital. Poor recording of feeding history may be reflective of a lack of gravity, lack of knowledge and confusion as to how feeding is assessed and reported. The professional education of clinicians who are working in a paediatric environment needs to include the importance of how to accurately to assess feeding history. As with growth assessment, the importance of understanding who is responsible for the assessment and recording of infant feeding history in the different hospital environments needs to be assessed to improve practice. The professional education of clinicians who are working in a paediatric environment needs to include the importance of how to identify and record feeding mode, type, frequency and change of feeding in the infant since birth. This requires knowledge of while important, not only the benefits of breastfeeding, which have become the major component of feeding education, but also pertinent and relevant information about formula feeding. All health professionals in developed countries should have the knowledge and skills to adequately identify and describe a comprehensive feeding history, to ensure feeding problems are not under-ascertained on presentation and/ or admission to hospital

Infant feeding

Breastfeeding as the standard of measurement for studies of infant feeding and hospitalisation, especially in terms of exclusivity, has been the predominant mark for infant benefit in prevention of illness. The importance of breastfeeding is widely known and promoted as the optimal infant nutrition.

Interventions

The literature that describes interventions previously proposed and utilised have primarily focused on nutritional screening tools. The nutritional screening tools, including The Screening Tool Risk on Nutritional status and Growth (STRONGkids)[148], Screening Tool for the Assessment of Malnutrition in Pediatrics (STAMP)[149], Paediatric Yorkhill Malnutrition Score (PYMS)[150] and the recent addition of the paediatric nutrition screening tool (PNST)[40]. The STAMP and PYMS

Screening tools are not validated for infants. Potentially in theory, nutrition screening tools are a solution, with studies reporting there value, but they require busy clinicians time to complete them. Ownership of the responsibility in the hospital environment for nutrition assessment is potentially a contentious issue. Any intervention in the area of assessment of infant feeding will not be successful long term until this is addressed, staffing levels are adequate and generic education is provided to health care professionals at an undergraduate level and reaffirmed at entry to a paediatric environment or in community practice.

Promotion of basic measurement and feeding history for all infants presenting and/or admitted to hospital, as the initial assessment of growth and feeding should be maintained and encouraged by institutional policy and review.

There are important messages from this study:

The systematic review found no clear relationship between mode of feeding and reduction of infant hospitalisation for illness in developed countries where breastfeeding ever versus never was measured.

The study findings from the parent questionnaire where the mode of feeding was consistently measured to identify if protective effects of breastfeeding in infants presenting and/ or admitted to hospital could be identified, would suggest that the choice of infant feeding and characteristics influence infant presentation and/ or admission to hospital, with a protective effect of breastfeeding reducing infection in some diagnostic categories. Importantly it is what this study adds identifying that firstly, nearly one fifth of infants who initiated breastfeeding had commenced formula feeding within the first six weeks of life. Secondly, that older infants were more prone to illness or injury when they had not been breastfed. Finally, the combination of unknown factors that may make breastfeeding continuation difficult or in some cases contraindicated. The clinical implications of infants commencing formula feeding in the first six weeks reverts to the original question the researcher had "is it the feeding problem that comes first or the illness". This emphasises the need to assess the infant feeding history on presentation and or admission to hospital. The early change to commence formula may also be due to lack of support or access to health professionals with a sound knowledge of infant feeding.

'Older infants were more prone to illness or injury when they had not been breastfed' may partly be explained by that infants with chronic illness throughout their life where breastfeeding was not

initiated due to ill health at birth. Finally, the combination of unknown factors that may make breastfeeding continuation difficult or in some cases contraindicated highlights that each infant who presents or is admitted, is an individual with a different feeding history, disease pattern and sociodemographic background. Further exploration of the factors identified and new approaches are needed to achieve optimal infant outcomes.

9.5 Research limitations

There are limitations inherent within the design and outcomes of any study. These may relate to the methodology, sample population and generalisability of results. This section of the thesis will discuss several of the key limitations inherent within the study methodology and outcomes, with more specific limitations having been incorporated into previous chapters.

Single site study

The researcher acknowledges the potential criticism that can be levelled at the chart audit and questionnaire phase of the study due to the study taking place at a single site. However, the scope of the study was limited by the time and funding available. The single site use may have displayed a different sociodemographic picture if multiple sites had been utilised, which may have produced a different result. In an ideal situation with unlimited time and financial resources, a larger study sample across multiple sites would have strengthened the findings of this study. In the design of this study, consideration was made so that replication could occur at other sites. The choice of ICD-10 codes for diagnostic grouping and socioeconomic data used is particularly mindful of this.

Data collection

The researcher chose to audit the medical records for the chart audit following randomization of the charts by another member of the research team. The positive aspects of this approach were that the researcher had previous experience in chart audit, was an experienced health professional and was consistent in identifying the data for audit. The limitation to this approach was that there was not an opportunity for the chart to be audited by a second person.

The researcher was also responsible for recruitment and data collection for the questionnaire phase of the study. The strength of this approach was that the researcher chose to use a face-to-face interview with participants to complete the questionnaire. The positives of this approach were that

although a convenience sample the benefit of the recruitment phase was that independent of literacy levels or self-selection to participate, the mother could continue to care for her infant, while responding to the questions. An unforeseen positive of this method from the staff and parent perspective was the 'entertainment value' and the distraction of having someone to talk to while waiting in either the emergency department or the surgical day procedure unit. Another positive of this method was the reliability of response, but it also enabled exploration of the response to the questionnaires. The limitation to this form of surveying is the interpretation of the response by the interviewer. The researcher was particularly mindful of this, had previous experience in this method of data collection and used quantitative data collection primarily to minimise bias. There were less than 10 refusals to participate in the questionnaire phase of the study. Unlike personally completed surveys the participant had the opportunity to clarify what the question was asking and the researcher was able to elicit more information if a response was unclear.

The other limitation to the questionnaire phase of the study was that the researcher could not be at the hospital 24 hours a day, seven days a week. The aim was to interview 300 mothers (parents) of infants during the six month period; this was surpassed with a total of 355 interviewed. The interviews took place across all days of the week from 0700 until 1100 hours.

The questionnaire phase of the observational study was initially planned as two parts; the first major questionnaire was that of the presentation data. The questionnaire comprised of 41 questions including infant, maternal and sociodemographic factors that may influence feeding. The recruitment for this phase of the study was initially planned to take place in the emergency department of the hospital only. It became apparent early in the study, that to capture a more diverse group of infants and more consistent and comprehensive data would ensue if the questionnaire was utilised with infants attending the hospital, independent of whether it was presentation and/or admission. This also provided consistency of data collection and avoided repeat duplicate questions. The additional questionnaire collecting admission data was completed if the infant was admitted to hospital and recruited for the first time in a clinical area (not the Emergency Department). In future studies this method could be replicated and the questionnaire modified to reflect this. The post admission questionnaire was planned as a small sample and many parents were unattainable at this phase of the study. Those who did complete the telephone questionnaire provided useful data and this is an area of the study that could be further developed in the future to identify if the infant had continued to have feeding problems or repeated illness episodes and the relationship between them.

Study population

A strength of this study is that infants were studied irrespective of the reason for presentation and / or admission. All parents of infants who presented and or were admitted were eligible to participate in the study regardless of diagnosis; this also became a limitation with the need to group diagnostic coding for meaningful analysis. The recruited population was not selective; they were recruited across all weekdays and times (except 0001-0645hrs). There was an over representation of post-natal presentations and/or admissions with similar findings previously reported. Chronic illness was also identified, which has been poorly reported in previous studies of infant presentation and/or admission to hospital. Martens and colleagues' study of "Predictors of hospital readmission of Manitoba newborns within six weeks postbirth discharge: A population based study" found that 6.3% of all readmissions were for a congenital anomaly with endocrine/metabolic/nutrition responsible for another 2%. Both categories have the potential for chronic illness requiring hospital presentations and/or admissions. The finding of this study was that 26% of infants were identified as having chronic illness. Infant age and chronic illness poorly reported in previous studies is therefore an important area for future research in terms of relationship to feeding, presentation and/or admission to hospital.

It highlights though that infants do not just present to hospital with illness and that studying particular diagnostic groups does not present a true picture of infant feeding in this setting. Another strength of this study is that five percent of respondents to the questionnaire phase of the study were indigenous Australians, which is representative of the number living in Queensland.

9.6 Recommendations and future directions

The audit was retrospective and future studies could link an audit post questionnaire phase of the study to identify not just the recording of growth and feeding history, but identify visits to the hospital within the first year of life and further review the growth and feeding history recorded at those times to obtain a clearer picture of the infant's journey during the first year.

This study was not planned to be a longitudinal study due to time and financial limitations but the opportunity is there to develop and complete a longitudinal study with a modified audit tool and questionnaire to reflect data requirements.

A longitudinal study of infants presenting and/or admitted to hospital in the first three months of life, commencing with the questionnaire phase of the study and then followed up for the first five years to obtain nutrition, growth and health data would provide new data previously not explored. Realising that this group may be vulnerable and potentially at risk of malnutrition would provide data identifying systemic problems with care of infants in this setting and provide a scientific base for future directions for care of this group. Linking the questionnaire participants with a yearly chart audit for the first five years would be useful to identify firstly attendances and if this has occurred, recording of feeding and growth during these times. This information if found to be significant could provide evidence for improved management of infants who present and/or are admitted to hospital.

Maternal health and the hospital experience for infants require further exploration to promote optimal nutrition for hospitalised infants.

This thesis informs all professional hospital staff of the importance of complete nutritional assessment of the infant at presentation and or admission to hospital.

The practices that are described in this thesis are not ‘new’ practice, and therefore currently should be routine in a paediatric setting. As previously mentioned and the reason for the audit were to confirm that these practices were not always done. Education available to health practitioners in any setting has not always highlighted the importance of optimal nutrition for infants presenting and/or admitted to hospital. Identification of reverse causality in relation to infant feeding and disease needs further exploration and discussion.

Focus of research on practical ways to support maintenance of at least some breastfeeding for a longer duration, which may benefit infants who present and/or are admitted to hospital, if clinically appropriate.

Nutritional and infant feeding awareness among health professionals will only result from increased education particularly during undergraduate training with an increased understanding of who is responsible for measuring growth and the recording of feeding history of infants at presentation and/or admission to hospital. The importance of a multidisciplinary team to assess nutrition in infants who present and/or are admitted to hospital cannot be underestimated.

This thesis provides paediatric researchers with an expanded evidence base for further exploration with regard to factors that involve infants, feeding and hospital.

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APPENDICES

CHILDREN'S HEALTH SERVICES QUEENSLAND
HUMAN RESEARCH ETHICS COMMITTEE

Professor John Pearn (Chair) 3365 5323
Mrs Amanda Smith (Co-ordinator) 3636 9167

Queens ©tnd Government

Queensland Health

Level 3, RCH Foundation Building
Royal Children's Hospital
Herston QW 4029 Australia
Telephone (07) 3636 9167
Facsimile (07) 3365 5455

9th October 2012

Mrs (Lesley) Alison Williams
Children's Nutrition Research Centre
Old Milk Kitchen
Royal Children's Hospital
Herston QLD 4029

Dear Mrs Williams,

HREC Reference number: HREC/12/QRCH/179
Project title: Feeding chamcteristics of infants presenting or admitted to a paediatric hospital.

Many thanks for your application of the above Low Risk Project. This has now been reviewed.

This HREC is constituted and operates in accordance with the National Health and Medical Research Council's (NHMRC) *National Statement on Ethical Conduct in Human Research (2007), NHMRC and Universities Australia Australian Code for the Responsible Conduct of Research (2007)* and the *CPMP/ICH Note for Guidance on Good Clinical Practice.*

I am pleased to advise the proposal meets the requirements of the National Statement on Ethical Conduct in Human Research and the Committee is happy to give approval.

This project has Ethics approval for the following sites:

- Royal Children's Hospital, Brisbane

The documents reviewed and approved include:

Document	*Version*	*Date*
Master Consent Form: Parent/guardian consent	I	05 October 2012
Master Patticipant Infotmation Sheet: Parent/Guardian infonnation Sheet	I	08 October 2012
Chatt Audit	I	08 October 2012
Questionnaire 2 Admission		08 October 2012
Questionnaire l-Presentation to hospital		08 October 2012
Telephone follow up questionnaire to admission questionnaire		08 October 2012
Application		
Covering Letter		05 October 2012

Please note the following conditions of approval:

1. We require an annual progress report (or sooner if the project is completed) concerning the study. This must include progress to date or outcome in the case of completed research. (In accordance with National Statement 5.5.3)

2. HREC approval is valid from 9/10/12 -9/10/15.

3. In accordance with the National Statement (3.3.12), before beginning the clinical phase of the research, researchers should register clinical trials in a publicly accessible domain.

4. If the project does not proceed, the Conunittee must' be informed as soon as possible. (In accordance with National Statement 5.5.6)

5. The Committee must be informed of any potential or realised problem with bioethical implications, if such occurs during the conduct of the research project.

6. Any serious adverse event (SAE) that arises in the context of this research, or involving a researcher conducting this research, must be reported to the Ethics Committee within 72 hours and reported to the sponsor (if applicable) within the stipulated lime frame.

   Serious Adverse Event Reports that are generated off-site may be (a) Serious Unexpected Adverse Reactions or (b) Serious Events which the Research Team believes cannot be related to the research intervention . The Research team must report incidents of (a) during multi-centre trials. Such are required to be submitted to the Chair of HREC on receipt by the researcher. A summary of the SAE repo1ts is to accompany the submission. Information required includes; patient details (age & sex), adverse event, outcome and the likelihood of the event being related to the study drug/device/procedure.

   With respect to all SAEs, the researcher must provide his or her opinion as to whether the SAE is directly related to the research intervention. A copy of the SAE Summary must be provided . (This can be obtained from the Ethics Officer)

7. Amendments to the research project which may affect the ongoing ethical acceptability of a project must be submitted to the HREC for review. Major amendments should be reflected in a revised online NEAF (accompanied by all relevant updated docwnentation and a cover letter from the principal investigator, providing a brief description of the changes, the rationale for the changes, and their implications for the ongoing conduct of the study). Hard copies of the revised NEAF, the cover letter and all relevant updated documents with tracked changes must also be submitted to the HREC and the RGO as per standard HREC/RGO SOP. Further advice on submitting amendments is available from: http/www health aid goy a11/ohrur/documentslregu/resrch_user_guide_yl.odf

8. The Ethics Committee may conduct a randomly identified audit of a proportion of research projects approved by the Committee. That audit process will look at such issues as;
   a. Security of Documents
   b. Consent Form Register
   c. Serious Adverse Events Register
   d. Withdrawal of Pm1icipants -who and why
   e. The de-identification of data

9. Ethical approval to undertake this research project is given on the understanding that you have an intention to publish your findings in a refereed journal or similar peer-reviewed forum. Ifyou do not have this intention, it is an absolute requirement that you notify the Ethics Committee formally. In this latter instance, approval for this research is not given at this time; and will require further negotiation. Your work must be in accordance with the following:

   National Statement on Ethical Conduct in Human Research:
   ltllp:/lwww.11ftmrc.gov.1111/g11/rfe/i11es/publ/c11tlo11se72-0
   Queensland Health Management Research Policy:
   lttip://www.Itealllt.qld.gov.mt/oft111rift tml/regu/l'esrclt mge po/icv.asv
   Declaration of Helsinki:
   ltllp:lwww.w11111.11etb11/30pub/icatiOJts/IOvolicieslb3/17cpd(
   - Guidelines under Section 95 of the Privacy Actl995 and Guidelines approved under Section 95A of the Privacy Act 1995.
   lttlp/lwww.lte11tlt.qld.gov.«11/olt111r/ltt111/lregul«ces_co11(lttlt_i11fo.«sp
   Queensland Health Privacy Guidelines IS42 & IS42A:
   lttp:/lw ww.ltealtlt.qltl.gov.a11/privacv/IS42A.11sv

10. Researchers should note, if not QLD Health employees, a Blue Card may be required for contact with children.

11. The Researcher must send the 'Notification of Commencement of Research Protocol' as soon as research begins. Status of the project will remain as 'Not Started' until this form is received.

Should you have any queries about the HREC 's consideration of your project please contact Amanda Smith (Co-ordin ator) or Professor John Pearn (Chairperson). The HR.EC terms of Reference, Standard Operating Procedures, membership and standard forms are available from: ht11r//www.hcalth.gllJ,sru'..nu/ohmrn11m1lregufreg11 homeusu

You aie reminded that this letter constitutes ethical approval only. You must not commence this research project at a site until separate authorisation from the District CEO or Delegate of that site has been obtained.

A copy of this approval must be submitted to the Research Governance Officer for authodsation from the CEO or Delegate to conduct this research within the Children's Health Service District.

The HREC wishes you eve1y success in your research.

Yours sincerely,

\\

Professor Alan Isles
Deputy Chair
Children's Health Services Queensland Human Research Ethics Committee

Cc: Ethics Committee Files

J:\Ethics\Ethics\2012 Projects\HREC-12-QRCH-179\williams091012rtf

Appendix 2 University of Queensland Ethics Approval

THE UNIVERSITY OF QUEENSLAND

Institutional Human Research Ethics Approval

Project Title:	Feeding Characteristics Of Infants Presenting Or Admitted To A Paediatric Hospital
Chief Investigator:	Mrs Lesley Alison Williams
Supervisor:	Prof Peter SW Davies
Co-Investigator(s):	Prof Peter SW Davies, Dr Robert Ware
School(s):	Children's Nutrition Research Centre, Discipline of Paediatrics and Child Health, School of Medicine
Approval Number:	2012001150
Granting Agency/Degree:	
Duration:	28th February 2014

Comments:

Expedited review on the basis of approval from the Children's Health Services Queensland HREC, dated 09/10/2012.

Note: If this approval is for amendments to an already approved protocol for which a UQ Clinical Trials Protection/Insurance Form was originally submitted, then the researchers must directly notify the UQ Insurance Office of any changes to that Form and Participant Information Sheets & Consent Forms as a result of the amendments, before action.

Name of responsible Committee:
Medical Research Ethics Committee
This project complies with the provisions contained in the *National Statement on Ethical Conduct in Human Research* and complies with the regulations governing experimentation on humans.

Name of Ethics Committee representative:
Professor Bill Vicenzino
Chairperson
Medical Research Ethics Committee

Signature _____ Date 15-10-2012

Children's Health Services (RCH)
Parent/Guardian Consent Form

Feeding Characteristics of Infants Admitted to Hospital

Parent/Guardian

I have read the above information. I have asked all of my questions and I have gotten answers. I agree to participate in this study.

_____ _____
Signature of Parent/Guardian Date

CHIEF INVESTIGATOR

I have fully explained to the parent/guardian ..... the nature and purpose of the questionnaire and I have provided the parent/guardian with a copy of the Patient Information Sheet.

_____ _____
Signature of Investigator Date

_____ _____
Print Name Position

INDEPENDENT WITNESS

I have witnessed the receipt of a Patient Information Sheet by the parent/guardian and exchanging of information between the investigator and the parent/guardian about the study.

An auditor witness would optimally discuss the study with the subject and witness the subject signature

_____ _____
Signature of Witness Date

_____ _____
Print Name Position

Appendix 4 Systematic literature review search terms

Pubmed Database
#1 (("search"[All Fields] AND "Breastfeeding"[MeSH terms] OR ("breast"[All fields] AND "feeding"[All fields]) OR "breastfeeding"[All fields]#2 ("Bottle feeding"[MeSH] OR ("bottle"[All fields] AND "feeding"[All fields]) OR "bottle feeding"[All fields]) OR ("formula"[All fields] AND "feeding"[All fields] OR "formula feeding"[All fields]) #3 "infant"[MeSH Terms])) AND (("Hospitalisation"[Mesh]#4 (("hospitalisation"[All Fields] OR "hospitalization"[MeSH Terms] OR "hospitalization"[All Fields]) OR ("hospitalisation"[All Fields] OR "hospitalization"[MeSH Terms] OR "hospitalization"[All Fields]) #5 (("Patient Admission"[MeSH])) OR (Present[All Fields] OR Presenting[All Fields] OR Presentation[All Fields] OR Admission[All Fields] OR Admissions[All Fields] #6 (("Statistics (Ber)"[Journal] OR "statistics"[All Fields]) OR ("epidemiology"[Subheading] OR "epidemiology"[All Fields] OR "epidemiology"[MeSH Terms]) #7 #1 OR #2 AND #3 OR #4 OR #5 AND #6 (83 articles identified)
Embase Database
#1'breast'/exp OR breast AND ('feeding'/exp OR feeding) OR ('breastfeeding'/exp OR 'bottle feeding'/exp OR 'artificial milk'/exp AND [humans]/lim AND [english]/lim) OR ('breast'/exp AND feed OR 'breast'/exp AND fed OR 'breast'/exp AND 'feeding'/exp OR bottle AND fed OR bottle AND 'feeding'/exp OR artificial AND 'milk'/exp OR 'baby'/exp AND formula OR 'infant'/exp AND formula) #2 ('child hospitalisation'/exp OR 'hospitalization'/exp OR hospitalisation) #3 ('infant'/exp OR infants OR 'baby'/exp OR babies)
#4 ('patient'/exp OR 'patients'/exp #5 'hospital admission'/exp #6 present OR presenting OR presentation OR admission OR admissions) NOT 'pre term’#7 ('statistics'/exp OR 'epidemiology'/exp)#1 AND #2 AND #3 OR #4 OR#5 OR #6 AND #7 (44 articles identified)

CINAHL Database

#1 (MH "Breastfeeding+")#2 (MH “Bottle Feeding” #3 Breastfeeding” OR “Breast fed” OR “Breastfeed” OR “Bottle feeding” OR “Bottle Fed” OR “Formula fed”# 4 (MH "Hospitalization+")#5 Hospitalization OR Hospitalisation #6 (MH "Infant+")#7 Infant OR Infants OR Baby OR Babies #8 (MH “Patient Admission”) #9 Present OR Presenting OR Presentation OR Admission OR Admissions #10 S8 OR S9 #11 Statistics OR Epidemiology
#12 S6 OR S7 #13 S1 OR S2 OR S3 #14 S4 OR S5 #15 S10 and S11 AND S12 AND S13 AND S!4 (11 articles identified)

Web of Science

#1 ("breastfeed")#2 (“breastfeed")#3 "Bottle feed"* #4 “Infant feeding"* #5 “Formula feeding"* #6 #5 OR #4 OR #3 OR #2 OR #1 #7 Hospitalisation #8 Patient admission
#9 Infant* #10 #7 OR #8 #11 #10 AND #9 #12 #11 AND #6 (48 articles identified)

DARE database

1 Infant feeding and Hospitalization 1 Result
2 Breastfeeding AND Infant hospitalization 0 Result
3 Breastfeeding AND Infant feeding AND Infant hospitalization AND presentation AND Admission 0 Result

Appendix 5 Characteristics of studies reviewed by full text, but not included in systematic literature review

Author/year	Paper details	Study population	Country/participants/sample size	Included/ Excluded	Reason for exclusion
Bahl,R., *et al.*, 2005	Infant feeding patterns and risks of death and hospitalization in the first half of infancy: multi centre cohort study. *Bull World Health Organisation* 83(6):p.418-26	Multicentre cohort study Outcome measures: all cause mortality, diarrhoea-specific and acute LRTI mortality and hospital admissions.	Secondary analysis of data from RCT on immunization-linked vitamin A supplementation *n*=9424 mother infant pairs in India, Peru and Ghana	Excluded by abstract	Developing countries WHO HIV RCT
Ball,T.M.and A.L.Wright. 1999	Health care costs of formula – feeding in the first year of life. *Pediatrics* 103(4):p.870-76	Community based samples	USA and Scotland *n*= 1588	Excluded by full text	Outcome not hospitalisation
Bartick,M and Reinhold,A. 2010	The burden of suboptimal breastfeeding in the United States: A pediatric cost analysis. *Pediatrics* 125(5):p. E1048-E1056	Pediatric cost analysis	USA 2005 birth cohort of the National Immunization Survey	Excluded by abstract	Outcome is not infant feeding or hospitalisation
Besculides, M.,*et al.*, 2005	Increasing breastfeeding rates in New York City, 1980-2000. *Journal of Urban Health: Bulletin of the New York Academy of Medicine.* 82(2):p.198-206	Women delivering infants in New York City Hospitals	USA Sample size- N/A	Excluded by abstract	Outcome is data on the method of infant feeding during the mother's admission for delivery (initiation rates).
Brown, A.K., *et al.*,	Factors relating to readmission	Retrospective analysis of all	USA *n*=391	Excluded by full text	Does not present data of

1999	of term and near- term neonates in the first two weeks of life. Early Discharge Survey Group of the Health Professional Advisory Board of the Greater New York Chapter of the March of Dimes. *Journal of Perinatal Medicine.* 27(4):p263-75	readmissions within 14 days of life in greater New York City			exposure to breastfeeding
Bruusgaard, D., *et al.*, 1993	Health service consumption and parent reported episodes of illness in children 0-3 years. *Scandinavian Journal of Primary Health Care.* 11(2):p.147-50	Prospective cohort for the first four years of life	Norway *n*=183	Excluded by full text	No outcomes for feeding
Cetinkaya,F., *et al.*, 2007	Nutritional vitamin B12 deficiency in hospitalized young children. *Pediatric Hematology and Oncology.* 24(1):p.15-21	Children identified as having Vitamin B12 deficiency in hospital	Turkey *n*=20	Excluded by abstract	Outcome not hospitalisation or feeding
Chatzmichael,A.,*et al.*, 2007	The role of breastfeeding and passive smoking on the development of severe bronchiolitis in infants. *Minerva Pediatrica.* 10(3) p.199-206	Cohort of infants aged 6-24 months admitted to hospital with acute bronchiolitis	Greece *n*= 240	Excluded by full text	Insufficient data for analysis and comparison No control
Dixon, D.L., *et al.*,.2010	Lower interleukin-8	Prospective cohort to	Australia *n*=18 breastfed	Excluded by abstract	No comparators of

	levels in airway aspirates from breastfed infants with acute bronchiolitis. *Pediatric allergy and immunology:official publication of the European Society of Pediatric Allergy and Immunology*. 21 (4 Pt 2):p.e691-6	examine the immune response of breastfed infants hospitalised with severe bronchiolitis compared with formula for controls	*n*= 11 formula fed		breastfed to formula fed
Fallot,M.E., *et al.*, 1980	Breast-feeding reduces incidence of hospital admissions for infections in infants. *Pediatrics.* 65(6): p.1121-4	Case control 0-3 months	USA *n*=136	Excluded by full text	Flawed comparative data. Insufficient data for analysis and comparison.
Haggkvist,A. P.,*et al.*, 2010	Prevalence of breast-feeding in the Norwegian mother and child cohort study and health service-related correlates of cessation of full breast-feeding. *Public Health Nutrition.* 13(12) p.2076-2086	Retrospective questionnaire Cohort study	Norway *n* = 29,621 mothers	Excluded by full text	Insufficient data for analysis and comparison No outcomes of relationship of feeding to illness / hospitalisation
Hall,R.T., *et al.*, 2000	Readmission of breastfed infants in the first 2 weeks of life. Journal of perinatology: Official journal of the California Perinatal Association. 20(7):p 432-7	Retrospective cohort study from chart review with ICD codes for hyperbilirubinaemia, dehydration, feeding problems or breastfeeding problems	USA *n*=152 infants who were breastfed (excluded non breastfed infants)	Excluded by full text	No comparator for feeding

Iacono,G.,*et al.,* 2005	Gastrointestinal symptoms in infancy: a population-based prospective study. Digestive and liver disease: official journal of the Italian Society of Gastroenterology and the Italian Association for the study of the Liver. 37(6): p.432-8	Cohort of infants 150 paediatricians followed 20 consecutive infants aged from birth to 6 months with specified symptoms	Italy n=2879 infants	Excluded by abstract	No comparator of feeding and hospitalisation
Krebs,N.F., 2011	Infant feeding matters. Journal of paediatrics, 159(2):p175-6	Editorial	USA Sample-N/A	Excluded by abstract	Review
Larsen,S.A. and Homer,D.R. 1978	Relation of breast versus bottle feeding to hospitalization for gastro enteritis in a middle class U.S. population. *The Journal of Pediatrics.* 92(3):p 417-8	Infants under 6 months of age hospitalized for gastroenteritis 'compared to a larger normal population'	USA *n*=35	Excluded by full text	Insufficient data for analysis and comparison
McNiel, M.E., *et al.,* 2010	What are the risks associated with formula feeding? A re-analysis and review. *Birth.* 37(1):p50-8	N/A	USA	Excluded by full text	Review article
Moritz,M.L., *et al.,*2005	Breastfeeding associated hypernatraemia: Are we missing the diagnosis? *Pediatrics.* 116(3):pe343-e347	Retrospective chart audit compared to a historical control group	USA Infants less than 29 days of age	Excluded by full text	No comparator No formula fed infants fulfilled criteria for inclusion in this study.
Oddie,S., *et al.,*	Hypernatraemic dehydration and breastfeeding: a	Retrospective chart audit on readmission	UK *n*= 8 of 907 readmissions	Excluded by abstract	Breastfeeding exposure- no useable data

	population study. *Archives of Disease in Childhood.*85(4) :p.318-20	within first 28 days of life			for comparison and analysis
Oddie,S.J., *et al.,* 2005	Early discharge and readmission to hospital in the first month of life in the Northern Region of the UK during 1998: A case cohort study. *Archives of Disease in Childhood.* 90(2):p.119-24	Retrospective case cohort study from medical records	UK *n*=408 readmitted infants	Excluded by full text	Insufficient data for analysis and comparison-feeding type only recorded at hospital discharge post birth
Papoff,P., *et al.,* 2011	Incidence and predisposing factors for severe disease in previously healthy term infants experiencing their first episode of bronchiolitis. *Acta Paediatrica, International Journal of Paediatrics*. 100(7): p.e17-23	Infants presenting with severe bronchiolitis requiring ventilator support	Italy *n*=310 16 presented with severe bronchiolitis (5.1%)	Excluded by abstract	No comparators of breastfeeding and hospitalisation
Pelleboer,R. A., *et al.,* 2009	A nationwide study on hospital admissions due to dehydration in exclusively breastfed infants in the Netherlands: its incidence, clinical characteristics, treatment and outcome. *Acta paediatrica.* 98(5):807-11	Infants hospitalised due to dehydration or under nutrition assessed by the Dutch Paediatric Surveillance Unit while exclusively breastfed.	Netherlands *n*= 158 infants under 3 months of age.	Excluded by full text	No comparators. Insufficient data for analysis and comparison.
Pisacane,A.,*e*	Breast feeding	Hospital	Italy	Excluded	Case control

t al., 1994	and acute lower respiratory infection. *Acta paediatrica.* 83(7):p.714-18	based case control study	*n*=74	by full text	and insufficient data for analysis and comparison
Quigley,M.A., *et al.,* 2007	Breastfeeding and hospitalization for diarrheal and respiratory infection in the United Kingdom Millennium Cohort Study. Pediatrics. 119(4): p.e837-42	Parental report of hospitalisation for diarrhoea and lower respiratory tract infection in the first 8 months after birth	UK *n*=15,890	Excluded by full text	Insufficient data for analysis and comparison
Quigley,M.A., *et al.,* 2009	Infant feeding, solid foods and hospitalisation in the first 8 months after birth. *Archives of Disease in Childhood.*94(2) :p.148-50	Assessment of the independent effects of solids and breast feeding on the risk of hospitalisation for infection in term, singleton infants in the Millennium Cohort Study	UK *n*=15,890 (same cohort as above)	Excluded by full text	Insufficient data for analysis and comparison
Smith,J.P., *et al.,* 2002	Hospital system costs of artificial infant feeding: estimates for the Australian Capital Territory. *Australian and New Zealand Journal of Public Health.* 26(6):p.543-51	Link the popn level estimates of ACT hospital episodes for selected feeding related morbidities with breastfeeding prevalence data and calculate cost	Australia *n*=1193 mothers of infants Data collected at four days, 8, 16 and 24 weeks post partum	Excluded by full text	Cost analysis Insufficient data for analysis and comparison
Spence,K.,*et al.,* 2011	Infant well-being following neonatal cardiac surgery. Journal of Clinical	Prospective cohort study	Australia 56 mother/infant pairs	Excluded by abstract	Post NICU Outcome not hospitalisations during first year

	Nursing. 20(17-18) p 2623-32				
Spiby, H., *et al.*, 2009	A systematic review of education and evidence-based practice interventions with health professionals and breastfeeding counsellors on duration of breastfeeding. *DARE database (National Institute for Health Research(NHS))*	Systematic review	N/A	Excluded by abstract	Systematic review Not question
Stuebe,A.M. and Schwarz, E.B. 2010	The risks and benefits of infant feeding practices for women and their children. *Journal of Perinatology*. 30(3):p155-162	Review	USA Sample-N/A	Excluded by abstract	No comparator of infant feeding and hospitalisation
Tarrant,M.,*et al.,* 2010	Breast-feeding and childhood hospitalizations for infections. Epidemiology. 21(6):p.847-54	Large population based cohort. Investigation between infant feeding and hospitalizatio n from any infection	Hong Kong 8327 mother infant pairs (7781)	Excluded by full text	Insufficient data for analysis and comparison
Thulier,D., 2010	A call for clarity in infant breast and bottle feeding definitions for research. Journal of Obstetric, Gynecologic and Neonatal Nursing.39 (6):p.627-34	Five new definitions for infant feeding	USA N/A	Excluded by abstract	Definitions of infant feeding
Tiewsoh,K.,*et al.,* 2009	Factors determining the	200 hospitalized	India *n*=200	Excluded by full text	Developing country

	outcome of children hospitalized with severe pneumonia. BMC paediatrics. 9:p.15	children aged 2-60 months			
Tjora,E.,2010	Early severe weight loss in newborns after discharge from regular nurseries. *Acta paediatrica.* 99(5):p.654-7	Review of medical records	Norway *n* = 38 infants readmitted for early severe weight loss from 37,321 infants	Excluded by abstract	Case control and insufficient data for analysis and comparison
Tyler,M and Hellings,P. 2005	Feeding method and rehospitalisation in newborns less than one month of age. *Journal of Obstetric, Gynecologic and Neonatal Nursing*.34(1):p 70-79	Retrospective chart review based on admission diagnoses	USA *n*=143	Excluded by full text	Insufficient data for analysis and comparison

Appendix 6 Chart audit

Queensland Government

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

Infant feeding, presentation and/ or admission to Hospital
Chart Audit (Phase 1)

Date: ☐☐ / ☐☐ / 201 Time ☐☐ : ☐☐ am/pm MRN:

Criteria	Yes	No	Comments
1.Date of birth			
2.Gender			
3. Gestational age			
4. Birth weight			
5. Admission weight			
6. Length			
7. Head circumference			
8. Percentile recording			
9. Feeding type			
10. Feeding mode			
11. Feeding frequency			
12. Changes in feeding since birth			
13. Discharge weight			
14. 'Bare' weight (clothing/nappy?)			
15. Diagnosis			
16. Postcode			

Version 1 081012

Appendix 7 Children's Health Services Parent/Guardian Information Sheet

Queensland Government

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

Children's Health Services
Parent/Guardian Information Sheet

Feeding Characteristics of Infants Presenting to Hospital

Feeding your baby during their first year of life can cause worry for you as a parent, especially if problems with feeding or your baby is ill. It is important to find factors that effect feeding in babies, especially those that are sick to find if there are some common reasons for coming to hospital.

What this study is about?

This research study aims to find out how well your baby has fed since birth and the reason you have come to hospital. While your baby will not receive benefit from your participation in this study, the results from this study will help babies in the future.

What is involved?

This study includes completing a questionnaire with the researcher. The questions are about how your baby has been fed since birth and your experience with your baby. There are some questions about your baby and you. If your baby is admitted to hospital you may be approached to complete a second questionnaire about your feeding experience while in hospital.

Participation:

This study is for the purpose of investigation and not treatment. Your decision whether or not to participate in this study will not prejudice your and your baby's future relations with the QLD Children's Health Services (RCH). If you decide to participate, you are free to withdraw your consent and to discontinue participation at any time. The decision to withdraw from the study will not affect your baby's routine medical treatment or their relationship with the people treating them.

Risk and discomfort:

There are no foreseeable risks to you or your baby if you decide to participate in this study.

Confidentiality:

This study is being conducted in accordance with National Health and Medical Research Council (NHMRC) ethical guidelines. All questionnaires and data will be kept in locked storage, accessible only by the research team. Data will be coded and de-identified. Auditors, ethics committee or regulatory authorities may access research data. Research data from this study may be published, however identifying data will not be used.

Contact:

If you have any concerns or wish to discuss any aspect of this study please contact Alison Williams, Professor Peter SW Davies or Dr. Robert Ware (details below). The QLD Children's Health Services (RCH) Human Research Ethics Committee (HREC) (and the University of Queensland Ethics Committee) has approved this study. Should you wish to discuss the study with someone not directly involved, in particular, any matters concerning policies, information about the conduct of the study or your rights as a participant, or you wish to make a confidential complaint, at any time, you may contact the Co-coordinator of the Ethics Committee on 36369167. If this telephone is unattended, please leave a message and your call will be answered as soon as possible.

If you agree to take part in this study please complete the consent form and return to the researcher.

Investigator: Alison Williams
Children's Nutrition Research Centre,
University of Queensland
Old Milk Kitchen,
Royal Children's Hospital Herston 4029
Telephone: 36465243
lesley.williams@uq.edu.au

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Appendix 8 Questionnaire phase 2

Queensland Government

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

Code:

Infant feeding and Presentation to Hospital

Parental Questionnaire (Phase 2)

This questionnaire asks about the infant you have brought to the hospital today

Date: DD/ DD/ 201 Time DD : DD am/pm MRN:

1. What is your relationship to this child?

D1 Mother Father

D3 Other ……. (please specify)

2. What best describes the reason you have brought your baby here now?

D1 High Temperature / Fever D2 Vomiting / Diarrhoea

D3 Difficulty Breathing/cough D4 Feeding problem

Ds Chronic Illness Ds Constipation

D1 GP Referral Da Other Referral

D9 Other (please specify) ……

3. When did you first notice that your infant had this problem?

D1 Less than 4 hours ago D2 4 - 24 hours ago

D3 Within the last 2 to 3 days D4 Within the last 4 to 7 days

Ds 1- 2 weeks ago Ds 3 - 4 weeks ago

D1 More than a month ago Da Since birth

Ds Other (please specify)…. ……

4. How was your baby delivered:

D1 Normal (Vaginal) D2 Caesarean Section (LUSCS) planned

D3 Forceps D4 Caesarean Section (LUSCS) emergency

Ds Breech Ds Ventouse Extraction

Ds Induction Ds Other……

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5. How many weeks pregnant were you when baby was born ? .....

6. Did your baby go to special care or intensive care nursery after they were born?

D1 Yes D2 No

How many days?.....

7. Is your baby a?

D1 Girl Boy

8. Baby's date of birth Date: DD / D D / 201

9. Baby's birth weight DDDD grams

10. In hospital after your baby's birth, how was baby fed?

D_1 Breastfed D_2 Formula

D_3 Other ..... (please specify)

11. How are you feeding your baby now?

D_1 Breastfed (EBM?) D_2 Formula

D_3 Other ..... (please specify)

12. If your baby is having milk other than breast milk is this ?

D_1 Formula Type..... D_2 Cows milk

D_3 Other ..... (please specify)

13. Has your baby ever had a 'dummy'/ pacifier?

D1 Yes D2 No

D_3 When do you use it ? .....

14. Is your baby drinking any other fluids?

D1 Juice Type..... D2 Water

03 Other ..... (please specify)

15. Is your baby drinking from?

O_1 Bottle ..... O_2 Cup.....

O_3 Other e.g. straw ..... (please specify)

16. Has your baby started eating solid food? At what age? .....weeks

O_1 Rice cereal/mixed cereal O_2 Weetbix (processed cereal)

03 Vegetables 04 Fruit

Os White meats (chicken.fish) 06 Red meat

07 Prepared mixed jars/cans (Supermarket) Os Egg

O_9 Other (please specify).....

17. Would you say your baby has been a "fussy" feeder at any time since birth?

O_1 Yes O_2 No

03 Comment.....

18. Has your baby ever been unwell before you came to hospital today?

O_1 Yes O_2 No

03 Comment .....

19. Before today have you visited any health professionals for your baby:

O_1 GP (Local doctor) O_2 Child Health Nurse

O_3 Paediatrician O_4 Physiotherapist

O_5 Chiropractor Pharmacy

Os Lactation Consultant Other.....

20. Have you ever given your baby?

01 Paracetomol (Panadol) $\square_2$ Ibuprofen (Nurofen)

O_3 Naturopathic drops $\square_4$ Herbal remedies

Os Vitamins/mineral s $\square_5$ Medication for constipation

O_6 Medication for reflux e.g gaviscon $\square_6$ Other.....

21. Would you say your baby has been an 'unsettled baby' at any time since birth?

D1 Yes D2 No

03 Comment. .....

22. Is the injury/illness you are attending the hospital for related to a condition that your baby is already known to have?

☐1 Yes No

Is this condition chronic? Yes No

Comment.....

23. What is the postcode of the area where this infant normally lives?

DODD

24. Does your baby attend a:

D1 Family daycare ☐2 Childcare centre

D3 Relative/ babysitter cares for this baby ☐4 Other

25. a) In the household in which this child resides, how many children live in the household?

01 02 03 04 05 06 07 08 09 010

b) Where is he/she placed among other siblings?

01 02 03 04 05 06 07 08 09 010

c) Other children in the household?

01 02 03 04 05 06 07 08 09 010

26. Mother's educational level:

O1 Year 9 or less ☐2 Year 10-11

O3 Completed Year 12 ☐4 Post secondary education

27. Mother's age:

O1 Under 20 20-29

03 30-39 40+

28. Father's educational level:

O1 Year 9 or less Year 10-11

03 Completed Year 12 Post secondary education

29. Father's age:

01	Under 20	02	20-29
03	30-39	04	40+

30. Do you identify as Indigenous?

01	Aboriginal	02	Torres Strait Islander
03	Aboriginal and Torres Strait Islander	04	Other

31. Is English your first language?

01	Yes		No

32. Have you been well since the birth of this baby?

01	Yes	02	No

Do you suffer from a chronic condition? Yes No

33. In a normal week do you drink?

01	Coffee	02	Tea (Normal.... Herbal.....)
03	Caffeinated soft drink e.g Coca Cola/Pepsi	04	Diet soft drink e.g Coke zero
05	Alcohol (Spirits/mixed drinks/fortified/wine)	05	Milk (type.....)
06	Juice (Orange/Apple/Cranberry)		Other……..……..……..……..

34. Are you currently taking?

01	Paracetomol (Panadol)	☐2	Ibuprofen (Nurofen)
03	Naturopathic mixtures	☐4	Herbal remedies
05	Vitamins/minerals	☐5	Medication for constipation
06	Medication for reflux e.g gaviscon	☐6	Other……

35. Are you on a special diet?

01	Vegetarian	☐2	Gluten free
03	No dairy food	☐4	Wheat free
05	Allergic to a food	☐5	Vegan
05	Other.....		

36. How many cigarettes a day do you smoke?

Do 01-2 03-5 05-10 010+

37.

38. If you have ever breastfed this baby and now don't what was the real reason you stopped breast feeding?

39. Is there anything else you would like to tell me about yourself, your family and their health?

D1 Yes D2 No

40. Is there anything else you would like to tell me about your baby, their health and feeding since birth?

O_1 Yes O_2 No

41. Do you feel that you needed more information about feeding your baby from birth?

O_1 Yes D2 No

Queensland Government

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

Code:

Infant feeding and Admission to Hospital

Parental Questionnaire (Phase 3)

This questionnaire asks about the infant you have brought to the hospital today

Date: DD / DD / 2013 Time DD : DD am/pm MRN:

1. What is your relationship to this child?

   D_1 Mother Father

   D_3 Other ..... (please specify)

2. Why has your baby been admitted to hospital?

3. When was your baby admitted to hospital?

   Date: DD I DD / 2013 Day of the week M T W T F S S

4. Was your baby's admission

   D_1 Planned (elective) Emergency (via emergency department)

   D_3 Transfer from another hospital From the outpatients department

   Ds Other.....

5. Is your baby a?

   D1 Girl Boy

6. Baby's date of birth Date: DD / DD / 201D

7. How were you feeding your baby when they were admitted to hospital?

   D_1 Breast feeding D_2 Formula (other milk feeding)

Vc1>io11l081012

8. Baby's birth weight DDDD grams

9. Baby's weight on admission : DDDD grams now: DDDD grams

10. When your baby was admitted to hospital, how was he/she fed?

D1 Breastfed (EBM?) D2 Formula

D3 Other ..... (please specify)

11. Now that your baby is in hospital how are they receiving nutrition?

D1 Breastfed D2 Bottle

D3 Nasogastric tube D4 Intravenous fluids

DS Food Other .....

12. Since your baby was admitted to hospital have they fasted for surgery or a procedure?

D1 Yes DZ No

D3 If so, how long ..... D4 How many times?.....

13. Have you been offered advice and assistance on your baby's feeding while in hospital?

D1 Yes DZ No

D3 other .....

14. If you had weaned your baby from the breast before baby was admitted (anytime since birth), what was the real reason for this?

15. Before your baby was admitted to hospital, had you recently changed any feeding, e.g type of formula feed, introduced solids,

☐1 Yes No

☐3 Comment

16. If you were breastfeeding when baby came into hospital and you are now weaning or have weaned your baby from the breast, what happened?

17. Has your baby ever been unwell before he/she was admitted to hospital?

O1 Yes O2 No

O3 Comment. .....

18. Would you say your baby has been a "fussy" feeder at any time since birth?

O1 Yes O2 No

03 Comment. .....

19. Is the injury/illness you baby is admitted to hospital for related to a condition that your baby is already known to have?

☐1 Yes No

Is this condition chronic? Yes No

20. What is the postcode of the area where this infant normally lives?

DODD

21. Has your baby been slow to put on weight since they were born?

O1 Yes O2 No

22. Mother's educational level:

D1 Year 9 or less ☐2 Year 10 - 11

03 Completed Year 12 ☐4 Post secondary education

23. Mother's age:

D1 Under 20 D2 20 - 29

03 30 -39 04 40+

24. Father's educational level:

O1 Year 9 or less D2 Year 10 - 11

03 Completed Year 12 04 Post secondary education

25. Father's age:

O1 Under 20 D2 20 - 29

03 30 -39 04 40+

26. Do you identify as Indigenous?

01 Aboriginal 02 Torres Strait Islander

03 Aboriginal and Torres Strait Islander 04 Other

27. Is English your first language?

01 Yes 02 No

28. Have you been well since the birth of this baby?

01 Yes 02 No

Do you suffer from a chronic condition? D1 Yes 02 No

29. Is there anything else you would like to tell me about yourself, your family and their health?

30. Do you feel that you could have received more information about feeding your baby from birth?

O_1 Yes 02 No

Queensland Government

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

Code:

Infant feeding and Admission to Hospital

Parental Telephone Questionnaire (Phase 38)

This questionnaire asks about the baby that was recently in hospital

Date: DD / DD / 201 Time DD : DD am/pm MRN:

1. What best describes the way your baby is now feeding?

D1 Breast
D2 Formula
D3 Mixed breast and formula
D4 Other milk
D5 Solid food
Ds Other.....

2. . What best describes the way your baby is now taking feeds (mode)?

D1 Breast
D2 Bottle
D3 Nasogastric tube
D4 PEG
Ds Spoon
Ds Self feeding solids
Ds Cup
Ds Other

eg. Supply line,

3. Has this changed since when your baby left hospital?

☐1 Yes
No
D3 Describe.....

4. Why do you think this change has occurred?

O_1	Baby now well	O_2	Bottle
3	Baby not interested in breastfeeding since leaving hospital		
4	Maternal milk supply has decreased		
0_5	Suited family circumstances		Baby not thriving
06	Other		

5. Have you experienced any feeding problems with your baby since leaving hospital??

O_1	Yes	O_2	No
03	Describe ……..…… ……. …… …….		

6. If baby has had feeding problems since leaving hospital, who have you sought advice from?

01	Paediatrician	02	GP
03	Lactation Consultant	Os	Friend
Os	Child health nurse	Os	Family
01	Pharmacy	Os	Hospital
09	Other (please specify) .. ……		

7. If baby has been unwell again since leaving hospital, whom have you sought advice from?

D1	Paediatrician	D2	GP
03	Lactation Consultant	Os	Friend
Os	Child health nurse	06	Family
01	Pharmacy	Os	Hospital

Other (please specify) . ...

8. Have you experienced any feeding problems with your baby since leaving hospital?

01 Yes O_2 No

O_3 Describe.....

9. Is there anything that you would like to say about your baby's feeding now?

O_1 Yes O_2 No

03 Describe ....

10. How many days did your baby stay in

hospital 03

Days.....

.....